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COVER IMAGE *Part of the Great Enclosure, Great Zimbabwe (photo Tendai Treddah Musindo).*



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This work is dedicated to my late parents, John and Maud Musindo, who could not see me make it this far. I know you always believed in me. As a child, I remember the encouragement and support you continuously gave me, and most of all, your teaching that the hand of God is above everything and will be my guide throughout my academic journey.

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# List of Abbreviations

| | |
|---|---|
| ASTER | Advanced Space-borne Thermal Emission and Reflection Radiometer |
| CODESRIA | Council for the Development of Social Science Research in Africa |
| CRM | Cultural Resource Management |
| CTI | Compound Topographic Index |
| DEM | Digital Elevation Model |
| EFC | Early Farming Communities |
| EMA | Environmental Management Authority |
| GIS | Geographical Information Systems |
| IT | Information Technologies |
| ITCZ | Inter-Tropical Convergence Zone |
| LCP | Least Cost Path |
| MRDC | Masvingo Rural District Council |
| NASA | National Aeronautics and Space Administration |
| NGO | Non-Governmental Organisation |
| NMMZ | National Museums and Monuments of Zimbabwe |
| NRF | National Research Foundation |
| OSL | Optically Stimulated Luminescence |
| SRTM | Shuttle Radar Topographic Mission |
| TauDEM | Terrain analysis using Digital Elevation Model |
| TWI | Topographic Wetness Index |
| UNESCO | United Nations Educational Scientific and Cultural Organisation |
| ZINWA | Zimbabwe National Water Authority |

# Preface

This book is an extension of a doctoral research that I completed with the University of Pretoria. The study focussed on the Great Zimbabwe World Heritage Site, where archaeological researches have largely concentrated on the monumental structures, iconic artifacts and the interpretation of the use of space. However, such studies have often presented Great Zimbabwe as an abandoned city and not as an inhabited one. This study deploys Geographical Information Systems (GIS) tools as well as ethnography to examine the centrality of water in the everyday lives of people living in ancient cities. This is informed by the need to view ancient cities as inhabited settlements with daily requirements of resources such as food and water and not just as ruined or abandoned ones. The study contends that water was one of the key resources in the everyday functioning of the city. As a result, there was an interface between water, water management and the built structures. Although acknowledging that the ethnographic present cannot be taken to represent what obtained in the prehistoric past without presenting challenges, the study explores how contemporary water sources around Great Zimbabwe and water management systems may help archaeologists to reconstruct water management systems to reflect the time when this ancient city was occupied GIS tools for hydrological modelling are employed to compute design flow around Great Zimbabwe. Using run-off models, the study argues for a re-interpretation of the use of some of the archaeological features found at Great Zimbabwe such as the *dhaka* pits. Through a cost surface analysis, the study provides an insight into how the residents of Great Zimbabwe traversed their landscape and transported water from sources to the dwelling places The study argues that the sustenance of the ancient city of Great Zimbabwe owed much to the availability of reliable sources of water. As evidence of water engineering, there are features such as terraces, *dhaka* pits and drain-holes, which demonstrate that the residents of Great Zimbabwe were aware of the need to channel water flow, control water run-off, store water and also protect stone walls from storm water. Overall, the study goes beyond the identification of potential and known water sources at Great Zimbabwe by deploying GIS tools, archival sources and ethnography to examine the archaeological implications of water and to analyse how it was entangled with the use of space as well as social formation

# Acknowledgements

This book would not have been possible without the support of many individuals and institutions. I am grateful for the financial support I received from the University of Pretoria throughout my studies. The National Research Foundation (NRF) funded bursaries through the Blue Skies Project, 'Collapse of Ancient Societies: Crises and Resilience in three spheres, Mapungubwe, Great Zimbabwe and Axum' (Grant No. 81694). In addition, I would also like to thank the Council for the Development of Social Science Research in Africa (CODESRIA) who funded part of my fieldwork through the Small Grants for Thesis Writing. My sincere gratitude also goes to Great Zimbabwe University who also funded part of my fieldwork through the university research grants. On top of that, the university generously granted me leave to enable me to conduct fieldwork

I am also grateful to Prof. Innocent Pikirayi for providing me with great mentorship and guidance. His diligence, knowledge and keen interest in my research helped me persevere even in the most difficult circumstances. Apart from this, Prof. Pikirayi also encouraged me to attend conferences and workshops as well as to publish some of my research findings during my studies. At the University of Pretoria, I benefitted greatly from interactions and often informal discussions with Dr Ndukuyake Ndlovu, Dr. Ceri Ashely and Ms. Mpo Maripane. Dr. Andrew Bevan mentored me when I was doing my MSc in GIS and Spatial Analysis in Archaeology at the University College London and continued to offer me advice as I proceeded with my studies and throughout this study. For this, I am eternally grateful. I also owe a debt of gratitude to Prof. Heinz Ruther (University of Cape Town) who has always encouraged me to pursue the endless possibilities in computer applications in archaeology. He also generously allowed me to participate in some of his own projects in Zimbabwe. I would likewise want to mention Federica Sulas (Aarhus University, Denmark) for taking her time to comment on my chapters. Ezekia Mtetwa (University of Uppsala) showed keen interest in my work and took time from his own PhD research to comment on some of my research findings.

I would like to acknowledge the support of colleagues and students at Great Zimbabwe University. Although I cannot mention all of them, here are some of them: Mrs Prosper Thlou, Dr. Thomas Thondlana, Dr. William Zivenge, Mr. Lesley Machiridza, Ms. Genius Tevera, Mrs. Christina Gwirai and my dear friend, Jane Sigauke-Nemaramba who sadly passed on before the completion of this study. In addition, I would also want to thank my students and research assistants who participated in my fieldwork.

The National Museums and Monuments of Zimbabwe (NMMZ), the custodian of the Great Zimbabwe World Heritage Site, allowed to me carry out research at the monument. In particular, I would like to thank Dr. G. Mahachi who is the Executive Director of NMMZ, Mr. Lovemore Mandima, the Director of NMMZ Southern Region, Mr Justin Magadzike, the Surveyor, and Mr. Munyaradzi E. Sagiya, Archaeologist and Curator, at the Great Zimbabwe World Heritage Site.

I would also like to acknowledge the support of friends who became sounding boards on whom I bounced many ideas. Although they are too many to mention, Dr. Joseph Chikumbirike and Mr. Mukundindishe Chifamba deserve a special mention. I benefitted a lot from their knowledge of GIS and other computer applications in archaeology.

Finally, I would to thank my family which stood by me throughout the period of the study. My sisters and brothers, thank you so much for believing in me. Special mention goes to my late sister Elma, who could not see this dream become reality. My husband, Joseph Mujere, took keen interest in my work and read and commented on some of my early drafts. My children Mufaro Lucas and Joseph Tafara deserve special appreciation for enduring my absence.

# 1

# Introduction and Background to the Study

## 1.1 Introduction

Water is one of the most critical resources in the sustenance of modern day cities. Consequently, it is one of the key considerations when planners choose sites for cities However, since it has few archaeological signatures, there are not many archaeological studies that have focussed on water and its archaeological implications Research has invariably focussed on those archaeological sites that contain evidence of water engineering in the form of canals, furrows, cisterns and terraces (see Wright 2006;Soper 1996a, 1996b, 2002; Kusimba and Kusimba in press). This has created a false impression that water was less important in those ancient cities that do not have visible evidence of water engineering

This study investigates the centrality of water in the everyday lives of people who lived at Great Zimbabwe ($11^{th}$ – $15^{th}$ centuries). It argues that Great Zimbabwe was once a prosperous ancient city which, like modern cities, required supplies of food, water, trade items and other raw materials and services This study contends that water was one of the key resources in the everyday functioning of the city. Consequently, apart from identifying sources of water, the rulers of Great Zimbabwe also had to establish a water management system that ensured that the city had adequate water for its residents. In trying to determine water sources, water management systems as well as the water budget at Great Zimbabwe, the study deploys an ethnographic approach as well as Geographic Information System (GIS) tools. On the one hand, ethnography helps in unravelling the traditional methods of managing water sources as well as identifying known water sources in the ethnographic present, whilst on the other hand, GIS tools are used in modelling hydrological processes at the site and providing insights into the likely products of such processes. Furthermore, the study presents insights on the relationship between the resident population and the water resources at this ancient city.

Being a World Heritage Site, Great Zimbabwe receives a large number of tourists every year and one of the key questions that visitors to the site ask concerns the use of space. This is a question that a number of archaeologists have sought to address with varying degrees of success This study contributes to this debate by providing some insights into the use of space at this site through an analysis of the relationship between sources of water and the built environment. Using approaches in settlement archaeology (Ashmore 2002; Kowalewski 2008; Anschuetz et al. 2001; McCoy and Ladeforged 2009), the study examines inter-site and intra-site spatial patterning. The research is, therefore, not just about water sources but also how water is entangled with the use of space and social formation.

The study employs Geographic Information Systems (hereafter GIS) to model spatial patterns and processes so as to obtain insights into the utilisation of resources necessary for the settlement's sustenance. One major interest is the modelling of hydrological processes using GIS approaches. Hydrological modelling using GIS applications has been argued to be the most convenient way of determining stream and river patterns of a region, particularly in semi-arid regions (Andersen 2008). The study also explores how hydrological processes could have shaped the settlement pattern exhibited at Great Zimbabwe. In addition, the research examines the effort needed to fetch water and bring it to the living quarters. These patterns of movement are also analysed in the light of the use of space at Great Zimbabwe. The study, however, takes cognisance of the fact that the site was not planned, built and settled, but there were different phases of occupation (Robinson 1961; Whitty 1961; Garlake 1973; Pikirayi and Chirikure 2011). It thus assumes that irrespective of the time period, water was a critical component in the day to day running of the city. Using space and hydrological models, the study re-assesses some of the theories posited for the rise and demise of this ancient city and its associated polities on the Zimbabwe plateau (see e.g Garlake 1973, 1978, Bannerman 1982; Pwiti 1991; Pikirayi 2001, 2006; Huffman 1972, 2009).

The study also draws comparisons with other ancient cities like Machu Picchu in Peru, South America, particularly on how water supply played a pivotal role in the survival of the city. Comparisons and insights are also gained from sites within Zimbabwe such as Khami, which is considered to be a possible successor of Great Zimbabwe (Garlake 1973, Chirikure et al. 2013b). Khami is known as the capital of the Torwa state (Beach 1980; Pikirayi 2001, 1993). The major interest in the comparison is the location of this site in relation to water resources, in particular the Khami River. The Nyanga terraces in Zimbabwe's Eastern Highlands also provide an interesting case where water engineering was done to enhance agricultural productivity in the pre-colonial period (see Soper 1996a, 1996b, 2002; Kusimba and Kusimba *in press*). Central to the study is the identification of water sources and potential water sources and modelling the hydrological processes to identify a systematic water supply and management system at the ancient city.

## 1.2 Great Zimbabwe: Environmental and Historical Context

### *1.2.1 Great Zimbabwe – Site Description*

Great Zimbabwe is situated 27 km south-east of Masvingo town (GPS coordinates 20° 16' 30" S, 30° 55' 60"E). It was declared a National Monument in 1936 and was subsequently added to the World Heritage List in 1986. The area declared the National Monument covers 720 hectares. However, to gain a broader understanding of the spatial processes, the study area covers a 10km radius. There is a general consensus among scholars that the people who built and inhabited the site were indigenous to the area (Caton-Thompson 1931; Summers 1963, 1966; Garlake 1973; Pikirayi 2001; Chirikure and Pikirayi 2008). From available radioarbon dates, the city flourished between the 13th and the 17th century (Chirikure et al. 2013b). These dates are, however, continuously being revised. The model that has previously been agreed on is that Great Zimbabwe developed as a city due to events that were happening in the Shashe-Limpopo area, particularly the decline of the Mapungubwe state. Thus, Great Zimbabwe started flourishing after Mapungubwe had been abandoned as a result of depletion of resources in the Shashe-Limpopo area in the 13th century. After the decline of Great Zimbabwe, in the later 15th century, Khami to the west and Mutapa to the north became the main centres (Garlake 1973). There is evidence suggesting that by the middle of the 15th century, Great Zimbabwe went into decline although it may not have been totally abandoned. This model has been generally agreed on by archaeologists as well as historians working in the southern African region. However, recent work at Mapela, a site in the Shashe Limpopo basin on the Zimbabwean side (Chirikure et al. 2014), has provided evidence which is enough to question this long agreed model and highlights the need to revisit it. From the new archaeological evidence from Mapela, there is an indication that it could actually be considered an earlier state system, with some materials discovered predating as well as some being contemporary to the ones found at the site of Mapungubwe. It is, thus, possible that Mapungubwe and Great Zimbabwe might have been contemporaneous (Chirikure et al. 2014). Figure 1 shows the location of Great Zimbabwe in relation to the mentioned sites, Mapungubwe, Mapela and Khami.

The stone architecture at Great Zimbabwe exhibits perhaps the most impressive workmanship of any structures associated with pre-colonial Southern Africa (Whitty 1961; Summers 1966; Garlake 1973; Pikirayi 2001; Chirikure and Pikirayi 2008). The site has unique drystone structures mainly concentrated on an area of 2.9 km² which equate to 30–40% of the 720 hectares which have been declared a national monument and World Heritage site (Chirikure 2017). There are also some drystone walls outside this 2.9 km² which, because of their location, have been referred to as 'peripheral' sites. The 'great' prefix for Great Zimbabwe was given by Theodore Bent as a way of distinguishing it from the several stonewalled structures of the same architectural canon (locally referred to as Zimbabwe, or *dzimbabwe*, meaning houses of stone) spread across the Zimbabwe plateau and adjacent regions (Bent 1892: 273). Thus, the

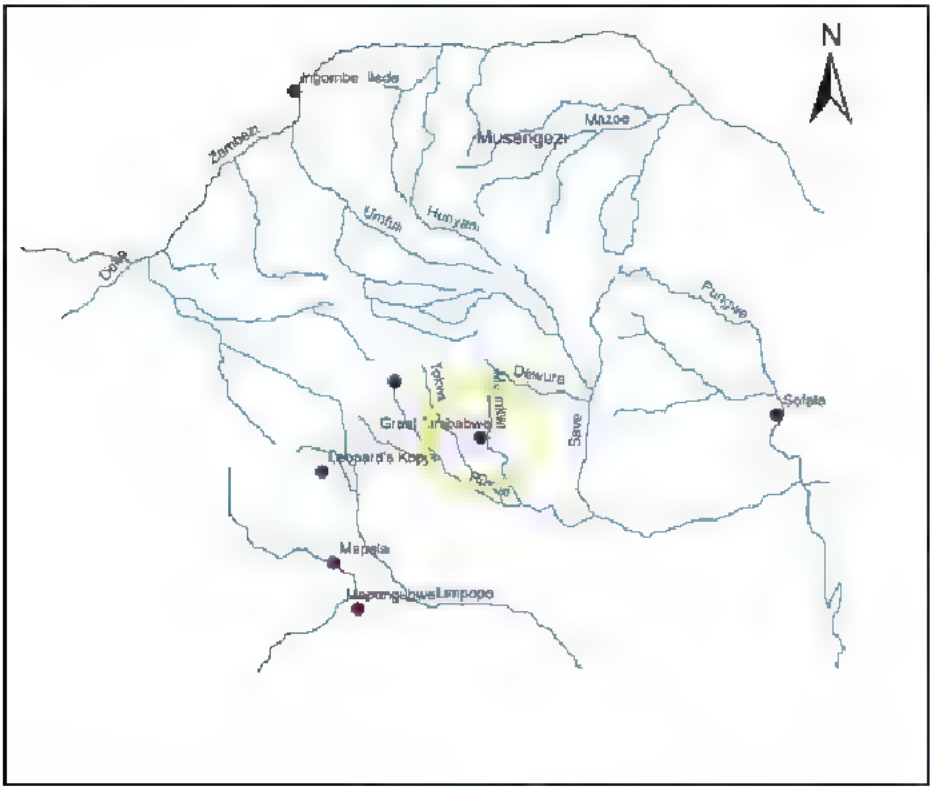



**Figure 1: Not to scale map showing the location of Great Zimbabwe (adopted from Beach 1980).**

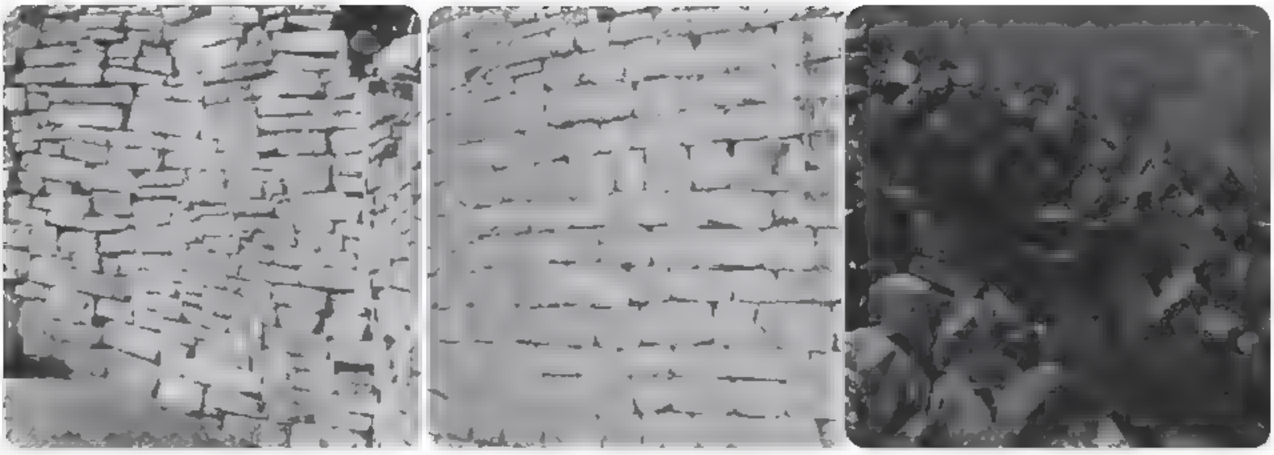



**Figure 2: Photograph showing the P, Q and R Construction styles at Great Zimbabwe.**

site was inscribed on the World Heritage list based on the United Nations Educational Scientific and Cultural Organisation (UNESCO) criteria (i), (iii) and (vi) which speak being unique in terms of artistry exhibited, being a testimony of a lost civilisation of the Shona and having the symbol of identity of the Zimbabwean nation respectively. The artistry exhibited at Great Zimbabwe is in the form of the stones that are laid in the absence of bonding material to make huge walls which in some parts are more than eleven (11) metres high. In terms of the construction of these walls, Whitty (1961) categorised the walls into three main distinct construction styles: P, Q and R (Figure 2).

The P-style is of poor quality because shaped stones are used in the construction of the walls without considering the size and shape. The stones are laid in such a manner that the longer dimension lies roughly in the horizontal plane (Whitty 1961: 291). Chronologically, the P-walling is the earliest. The Q-style on the other hand has walling of the best quality because stones of almost the same size and shape are used in the construction. The Q-walling exhibits an element of consistency in the construction style. Lastly, R-style involves rough walling where stones which are not shaped in any manner are used in the construction. Inconsistencies in the shape and size of the stones make the walling rough. The R-walling is the latest in terms of the construction sequence. In some instances, there is a combination of the construction styles which has been argued to represent the intermediary or transitional phase in the construction sequence (Whitty 1961: 294). The intermediary styles are the PQ, QR as well as the PQR (Whitty 1961; Chipunza 1994, 1997). Garlake (1973: 17) argues that these walls never supported roofs since the areas they enclose are too large and irregular to have been roofed by any system. This makes drystone walling the major feature at the ancient city.

Besides the built-up area, another characteristic feature of the site are the large open spaces which comprise mud floors as well as scattered potsherds rendering the whole area that was declared a national monument archaeologically sensitive. These open spaces have been viewed from a commoner settlement perspective where it is argued that while the elite lived within the enclosures, the commoners occupied the 'open spaces' (Huffman 1996a). This 'commoner-elite' interpretation has since been questioned by continued research on the site (see Chirikure and Pikirayi 2008; Chirikure et al. 2016). Although the built structures are the most prominent features, the open spaces are also critical in understanding Great Zimbabwe hence the call for a holistic approach to the site rather than viewing it as composed of individual structures. Based on this understanding, the study analyses the whole Great Zimbabwe landscape rather than just the monument.

### *1.2.2 Great Zimbabwe Layout*

The built area is divided into three areas, the Hill Complex, the Great Enclosure and the Valley Ruins (Figure 3).

*Hill Complex*

The Hill Complex referred to in early texts as the Acropolis (Bent 1895; Hall 1905a; Randall-MacIver 1906) is characterised by the earliest construction style or P-walling. The P-walling has a less regular shape, and less well matched, fitted and more loosely constructed blocks (Whitty 1961). It is generally agreed that the Hill Complex comprises some of the earliest strutures (Whitty 1961; Collett et al. 1992; Chipunza 1994, 1997; Chirikure et al. 2013b, 2014). Within the Hill Complex, there are also small walled enclosures connected by narrow, twisting passages. Though charatерised by a number of enclosures, the most significant one in this complex is the western enclosure which is caped by towers and monoliths (Garlake 1973). This enclosure also features evidence of long occupation as revealed by several excavated platforms. Each platform has been taken to represent a different occupation period. Then there is the Eastern Enclosure where most of the soapstone birds

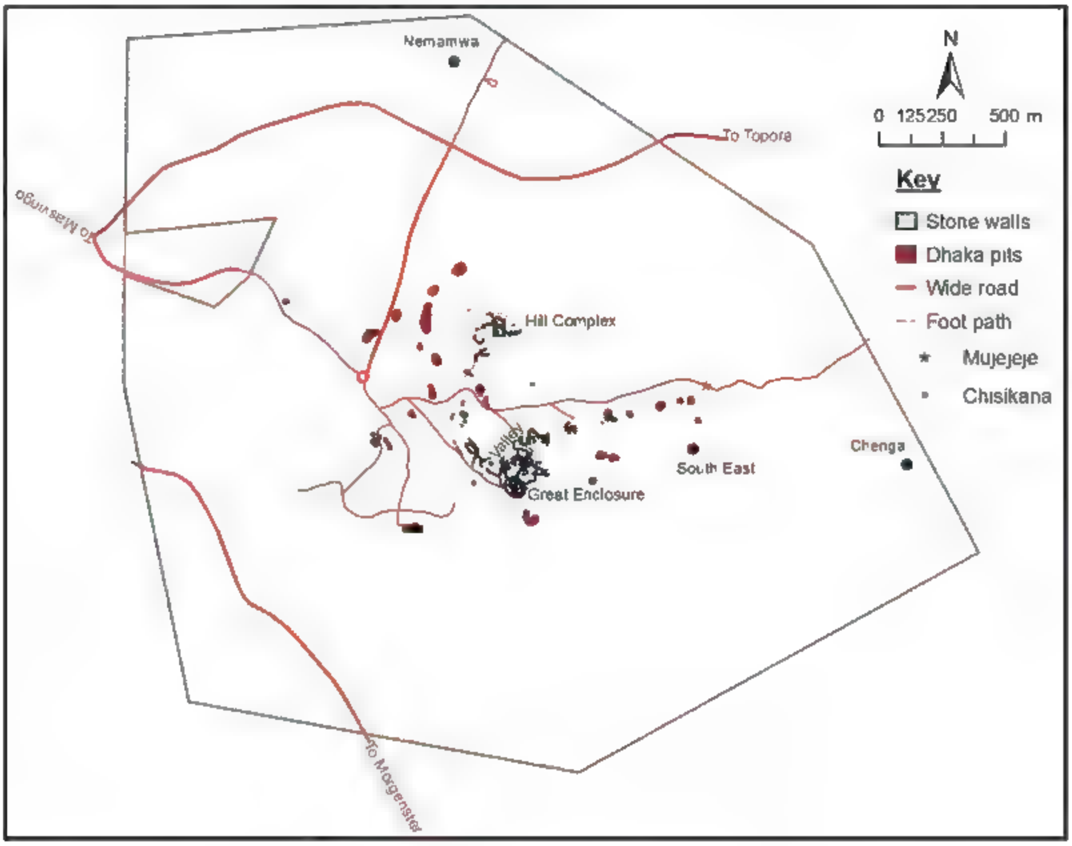



**Figure 3: Great Zimbabwe site plan (digitised from 1: 5000 map of Great Zimbabwe).**

were found. As a result of the discovery of the soapstone birds in this enclosure, scholars have concluded that it was used for ritual purposes (Huffman 1996a, 1984; Matenga 2011). The Hill Complex is accessible from the north western and the southern sides via the so-called Ancient path to the south, and the Watergate path to the north-west.

*Great Enclosure*

The Great Enclosure (Figure 4-6), is known in earlier texts as the 'Temple' or the 'Elliptical Building' (see Bent 1892, 1893b; Hall 1905a; Randall-McIver 1906). It was Bent (1892) who first used the term 'Elliptical Building', equating the structure to some Phoenician temples. This

**Figure 4: View of the Great Enclosure from the Hill Complex (photo by author).**

**Figure 5: A 3D view of Great Enclosure and Great Zimbabwe landscape.**

association was meant to support a foreign origin of the city, a theory that was later dismissed by scholars like Getrude Caton-Thompson, Roger Summers and Peter Garlake (Garlake 2002). In Garlake's words (1973: 27), architecturally, the Great Enclosure is the largest prehistoric structure in Sub-Saharan Africa. Accoding to Garlake (1973), the Great Enclosure is also the earliest struture in the valley. It exhibits the greatest workmanship with regularly shaped stone blocks used in the construction hence the Q-walling. Another distinctive characteristic of the Great Enclosure is the chevron pattern decorated at the back of the wall as well as the monoliths on the top of the walls

*The Valley Structures*

The Valley Structures are composed of a series of small enclosures. These enclosures have been named after the early Europeans who visited the site hence the names: Renders, now known as Central Ridge, Mauch (East Ruin), Phillips (Central Valley), Maund ruin (Eastern Ridge) as well as Posselt ruin (Western Valley). Archaeological research in this part of the site helped solving the debate regarding the builders of the structures. In particular, excavations of the Maund ruins yielded the key evidence for Caton-Thompson (1931) to argue for an African origin of Great Zimbabwe. The Valley structures have also yielded archaeological evidence that relates to the ritual aspects of the site (see Matenga 2011). The Zimbabwe bird, which is a national symbol of identity, found on the Zimbabwe flag and other national organisational and individual emblems, was discovered in the Posselt ruins. Thus, although the Valley Structures are not structurally huge as compared to the Great Enclosure and the Hill Complex, they have been a source of crucial information relating to the site. In terms of workmaship of the walls in the valley, there is a combination of the poor (P) and the superior (Q) style walling

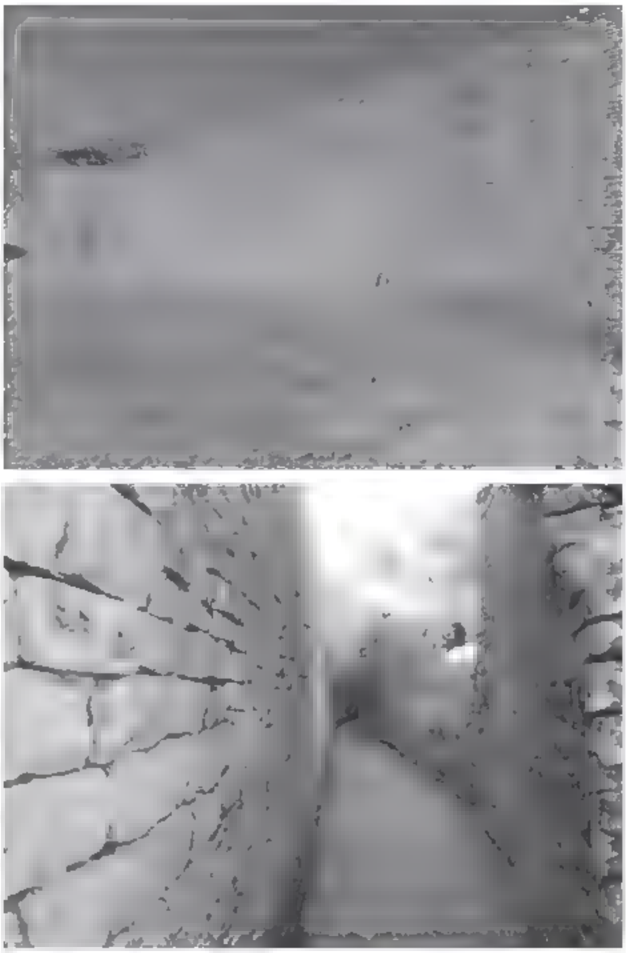


**Figure 6: Workmanship exhibited in the inside as well as the Parallel passage of the Great Enclosure (photos by author).**

*Open Spaces*

The Great Zimbabwe landscape comprises 'open spaces' with clay (*dhaka*) platforms. The *dhaka* platforms have been interpreted as house floors together with the related raised

platforms However, these are not confined to the 'open spaces' as some are also found within the stone enclosures The *dhaka* structures within enclosures include a circular structure in the Great Enclosure and the floors in the western enclosure of the Hill Complex. Garlake (1973: 20) argues that the *dhaka* once paved the interior of every courtyard or enclosure and also covered stone steps, platforms and other small stone structures The connectedness of the walls and these *dhaka* structures is well demonstrated from the results of the excavations that were done on the Maund ruins in the Valley structures The excavations on the walls which had largely remained untouched by early antiquarians yielded ten (10) circular structures made of this *dhaka* which were built against these stone walls (Caton-Thompson 1931). Garlake (1973) has confirmed the ubiquitous nature of the *dhaka* deposit at Great Zimbabwe highlighting that every excavation done at the site has revealed layer after layer of this deposit. Besides using material culture such as pottery, Caton-Thompson (1931) analysed the settlement pattern as exhibited by *dhaka* structures and argued that the site was of African origin In addition to platforms, *dhaka* is also used with reference to a number of sizeable pits located within the site. Garlake (1973) contends that the huge pits within the monument area were the sources of the clay used in the construction of the *dhaka* structures These pits are mainly concentrated on the western and southern base of the Hill Complex. The mining of the raw material for the construction of the *dhaka* structures has resulted in these pits being referred to as the *dhaka* pits A detailed examination of these features will be presented in Chapter 5

When one looks at Great Zimbabwe, the tendency is to focus on the built structures. The archaeology of the site has been mainly biased towards the interpretation of the material evidence, its monumentality as well as the movable archaeological artifacts such as the soapstone birds and the potsherds (both local and exotic). Wilkinson (2003: 336) argues that the open spaces on the landscape have mainly been viewed as forming merely negative space around the other types of land-use; alternatively though, these negative spaces can be read as potentially having specific functions. Todd et al. (2004) emphasised the need to view landscapes within a taphonomic framework where they are a result of an 'evolving and integrated set of cultural, biological, climatological, chemical and geological processes.' It is in the same vein that very few recognise Great Zimbabwe as a landscape where there was an interaction of the features through the various open spaces. Hence to get a fuller understanding of Great Zimbabwe, there is need to consider the open spaces as part and parcel of the entire built environment.

*'Peripheral' Sites*

Besides the Great Enclosure, Hill Complex, Valley Structures and the open spaces which are viewed as the core of the Great Zimbabwe, there are a number of other stone walled structures found within the Great Zimbabwe landscape. Chenga Ruins, East Ruins located east of the 'core' as well as Nemanwa Ruins to the north are some of these 'peripheral' sites It is most probable that accessibility to these has made them to be referred to as peripheral as some like the East Ruins are not located not very far from the 'core'. These sites are located at distances which range from a few hundred metres away from the 'core' (e.g the East ruins) to few kilometres (Chenga Ruins). Despite being labelled 'peripheral', these are an integral part of the Great Zimbabwe landscape, hence the need to be incorporated in studies that deal with the landscape

*On the Function, Rise and Collapse of Great Zimbabwe*

Scholars have made attempts to establish the reason behind the establishment of Great Zimbabwe. Mennell (1903) for example has argued that the massive walls at Great Zimbabwe were constructed for security reasons Thus, the structures may have served a mainly defensive purpose. However, other scholars argue that the walls appear to have been primarily built for other purposes disconnected from defence (Garlake 1974). Citing the case of the wall on the southern side of the Hill Complex, which is built on an almost vertical cliff, Garlake (1974) dismisses the argument that the site could have been established for defence. He argues that the walls are highly visible, which instead of repelling enemies, actually attracts attention (Garlake 1974: 8) Mallows (1986) uses the absence of water sources needed in times of siege within the Hill Complex to argue against the idea of the site being built for defensive purposes. To add on, the disjointed nature of the walls is also cited as one reason why the stone walls could not have served defensive functions. The elaborate stone walls could have been built for prestige or as a sign of wealth

A number of arguments have been put forward to explain the rise and fall of the ancient city of Great Zimbabwe. Scholars agree that the rise and the ultimate demise of the city cannot be explained by a single factor. The establishment as well as the development of the ancient city of Great Zimbabwe is attributed to several factors Among the key factors which contributed to the rise of Great Zimbabwe are environmental conditions, cattle accumulation, religion, trade and population growth (Garlake 1973; Pwiti 1991; Pikirayi 2006; Pikirayi and Chirikure 2011). The climatic conditions which made the area tsetse free are among the factors that are believed to have led to the development of Great Zimbabwe (Garlake 1978). These climatic conditions together with the availability of other resources such as gold and good pastures are also among the factors thought to have contributed to the development of this ancient city. The presence of favourable environmental conditions has also been highlighted by scholars like Garlake (1978) who discusses the presence of fertile lands north of the site and attributes the heavy clay soils to the presence of metamorphic rocks which are part of one of the gold belts in the region (Garlake 1973: 15). In this region, gold is sourced today as confirmed by the rush for gold currently taking place to the north west of Great Zimbabwe Recently, there has been an influx of gold panners (*makorokoza*) in Manyama area, about 15km from Great Zimbabwe along

the Masvingo—Great Zimbabwe road.[1] The artisanal gold panning has started to be regularised and currently small scale miners have replaced the *makorokoza*.

To the south of the Great Zimbabwe site is an area with good grasslands suitable for cattle keeping. The availability of good pasture land was also noted by scholars such as Garlake (1973) It is in this regard that wealth in the form of cattle is also considered to be another factor that contributed to the development of Great Zimbabwe (see Garlake 1978; Hall 1987; Sinclair 1987; Pwiti 1991; Pikirayi 2001; Moffett and Chirikure 2016). Cattle were used as a source of wealth which led to social differentiation and the emergence of an elite class Moffett and Chirikure (2016) argue that the dominance of cattle bones in excavations is evidence of the importance of cattle at Great Zimbabwe Scholars such as Huffman (1972) and Pwiti (1991) have argued that the cattle factor is too simplistic and instead, he supports the trade hypothesis as a plausible explanation for the establishment of Great Zimbabwe. Trade is considered to be one of the important factors in the development of states in southern Africa and Great Zimbabwe in particular. Trade resulted in the introduction of luxury goods into the system The unequal access to these luxury goods resulted in the widening of the socio-economic gap between the rulers and ordinary people at places like Great Zimbabwe. A few people had access to luxury items such as gold and ivory. As suggested by Pwiti (1991: 126), the trade goods represented some form of wealth, hence the ability to manipulate the process of trade resulted in the emergence of elite classes Those with access to these goods maintained their positions by assembling armies. Evidence of local and international trade in the form of such material culture as glass beads, Chinese porcelain and gongs has been found at Great Zimbabwe.

Religion is one of the factors that has also been considered in the case of the development of Great Zimbabwe. The argument that Great Zimbabwe was a religious centre has been reiterated by many scholars (Garlake 1973; Huffman 1982; Matenga 2011; Fontein 2006b, 2015). Garlake (1970) argues that the religion could be the main reason why Great Zimbabwe was located at the site where it is Thus, for Garlake, Great Zimbabwe served as a religious shrine. Garlake (1970) uses the absence of recognised trade routes and the distance between the site and the nearest ore deposits, which he considered as too much as evidence of the minimal role natural or geographic factors could have played in the establishment of Great Zimbabwe He also dismissed the argument that Great Zimbabwe was built for defence purposes by arguing that the distribution of the zimbabwes does not correlate with any specific ecological areas and few, 'if any', were built or sited for defence Garlake (1970) argues that a feasible explanation for the position of Great Zimbabwe can be given in terms of religious authority and sanctions, a common feature in African societies (Garlake 1970: 26). The importance of religion in state establishments is its role in maintaining political power. Sacred leadership is therefore seen as one of the factors that led to establishment and development of the ancient city of Great Zimbabwe (Huffman 1972, 2009). Leadership was thus justified through religion and ideology (Hassan 1993, 1994)

On population growth as a factor that led to the demise of the ancient city, scholars such as Huffman (1986) have suggested that at its peak, Great Zimbabwe had a population of around 18000 people. Huffman (1986: 323) estimated that Great Zimbabwe had a minimum population of 11000. He arrived at this figure by first 'extrapolating the densities of huts found in excavations, both inside and outside stone enclosures, to comparable areas throughout the township, second by calculating the adult population with the ratio of one adult to each kitchen or sleeping hut, and finally by computing the total estimate from a relatively recent population pyramid for the country' (Huffman 1986: 323) Huffman also argues that if one uses the population statistics from the 19th century, a less conservative population figure of around 18000 people is obtained. However, Huffman (1986)'s population figures are largey based on extrapolations which do not consider the availability of resources utilised on a daily basis such as water. Whilst there is no doubt that Great Zimbabwe was the centre of a large kingdom, the population figures often suggested remain highly speculative Chirikure et al. (2017) combined a number of approaches such as demographic back-projection and assessment of resources available to sustain the agricultural economic base of the residents at Great Zimbabwe and argues for a population of between 4000 and 5000. It is, therefore, still possible that this population became too huge to be supported by available resources hence people started migrating in search of resources that had become scarce at Great Zimbabwe. This research thus pays particular attention to water, analysing how it played a role in the day to day lives of the residents at the Great Zimbabwe ancient city. In order to have an appreciation of the water resources around Great Zimbabwe, it is important to examine the catchment of the site. The next section therefore examines the water resources around Great Zimbabwe.

### *1.2.3 River Systems*

For the Zimbabwean plateau, the major drainage systems are the Zambezi, Shashe-Limpopo and Save-Runde River systems that dissect the plateau and all other tributaries feed into these river systems. The main feature in the hydrology catchment of Great Zimbabwe is Lake Mutirikwi, which was created by damming Mutirikwi River in 1960 as detailed below Mutirikwi is therefore considered a sub-catchment

The Mutirikwi River drains into Runde River and has three main tributaries: Pokoteke, Mucheke and Shagashe

[1] http www.zbc.co.zw/news-categories local-news 64217-illegal-panners-invade-masvingo, http://www.southerneye.co.zw/2016/01/04/gold-panners-threaten-masvingo-great-zim-road/. Accessed online, 23 August 2016

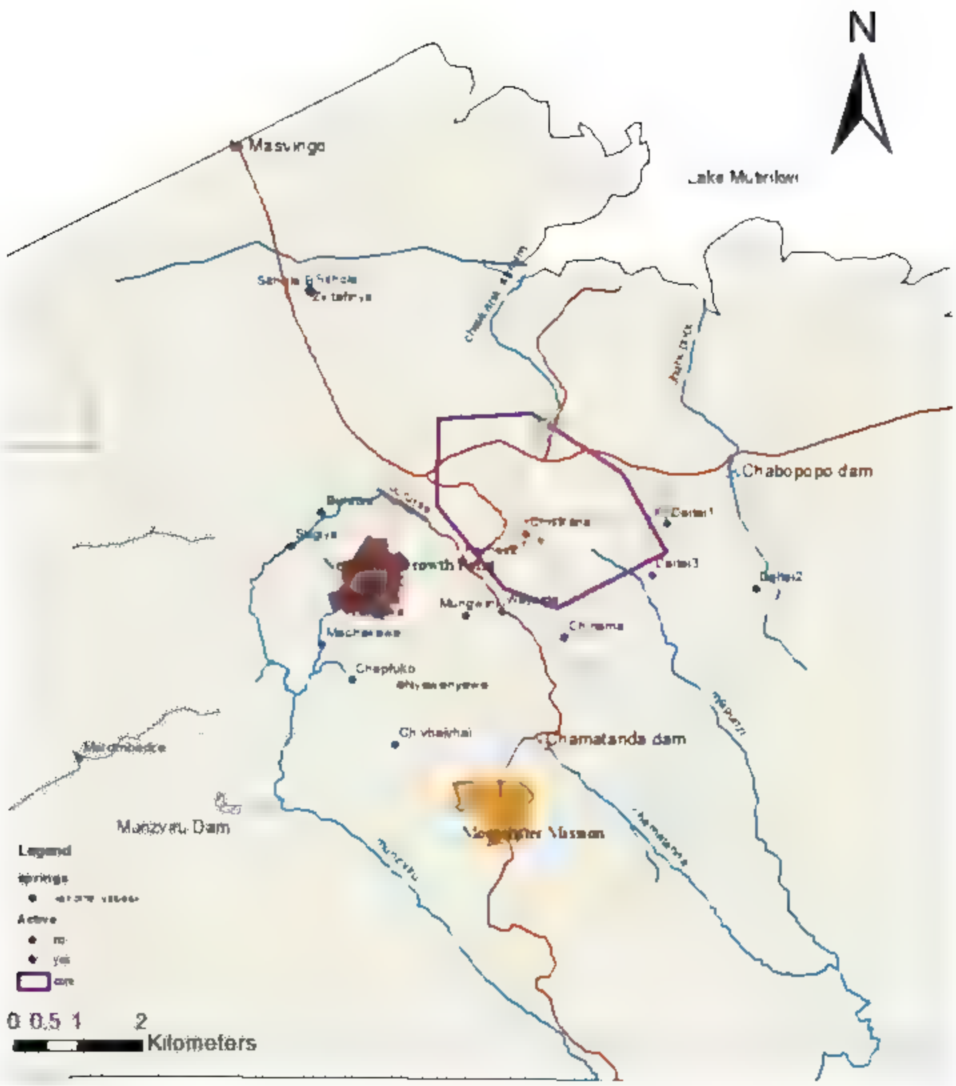



**Figure 7: Map showing the position of Great Zimbabwe and tributaries in the Mutirikwi sub-catchment.**

It is the Mutirikwi River which was dammed to make the now Lake Mutirikwi which currently supplies the City of Masvingo and the south west Lowveld sugar estates with water. Lake Mutirikwi was commissioned in 1960 and covers an area of 90km². Prior to the construction of the Mutirikwi Dam, the area directly draining Great Zimbabwe was Shagashe River. Besides these major tributaries, there are several other tributaries. Tributaries which flow directly through the Great Zimbabwe monument and those within a few kilometres from the site are Chabopopo and Chisikana which drain directly into Lake Mutirikwi (Figure 7). Directly passing through the monument area is Mapudzi stream which starts near the Ancient City Lodge. The stream flows into Chamatanda, which then finds its way into Munzviru River.

Most of these tributaries are, however, ephemeral only because they flow for short periods per year. Despite the ephemeral nature of these streams, they are usually a source of water for small gardens during the dry season. In the study area, the most prominent is the Chabopopo with its source in the south side of Boroma Range. Unlike other tributaries, this river is perennial and feeds into the Shagashe River (and now Lake Mutirikwi after the damming of the river in the 1960s). The catchment characteristics which include appearing and disappearing of surface flows are influenced by the climate as well as the underlying geological formation.

### *1.2.4 Great Zimbabwe Geology and Underground Water*

*Geology*

Zimbabwe is part of the African shield with its old and rigid rocks, which are characterised as a granite-greenstone complex. These geological formations have an impact on the availability of ground water and also the water management systems that can be put in place. As Crouch (1996) argues, the geological base is one of the key factors that need to be considered in urban development and water management. This is vital not only in determining water sources but also in understanding the topography and geomorphology of a site, the nature of its soil and the availability of building materials (Crouch, 1996: 233).

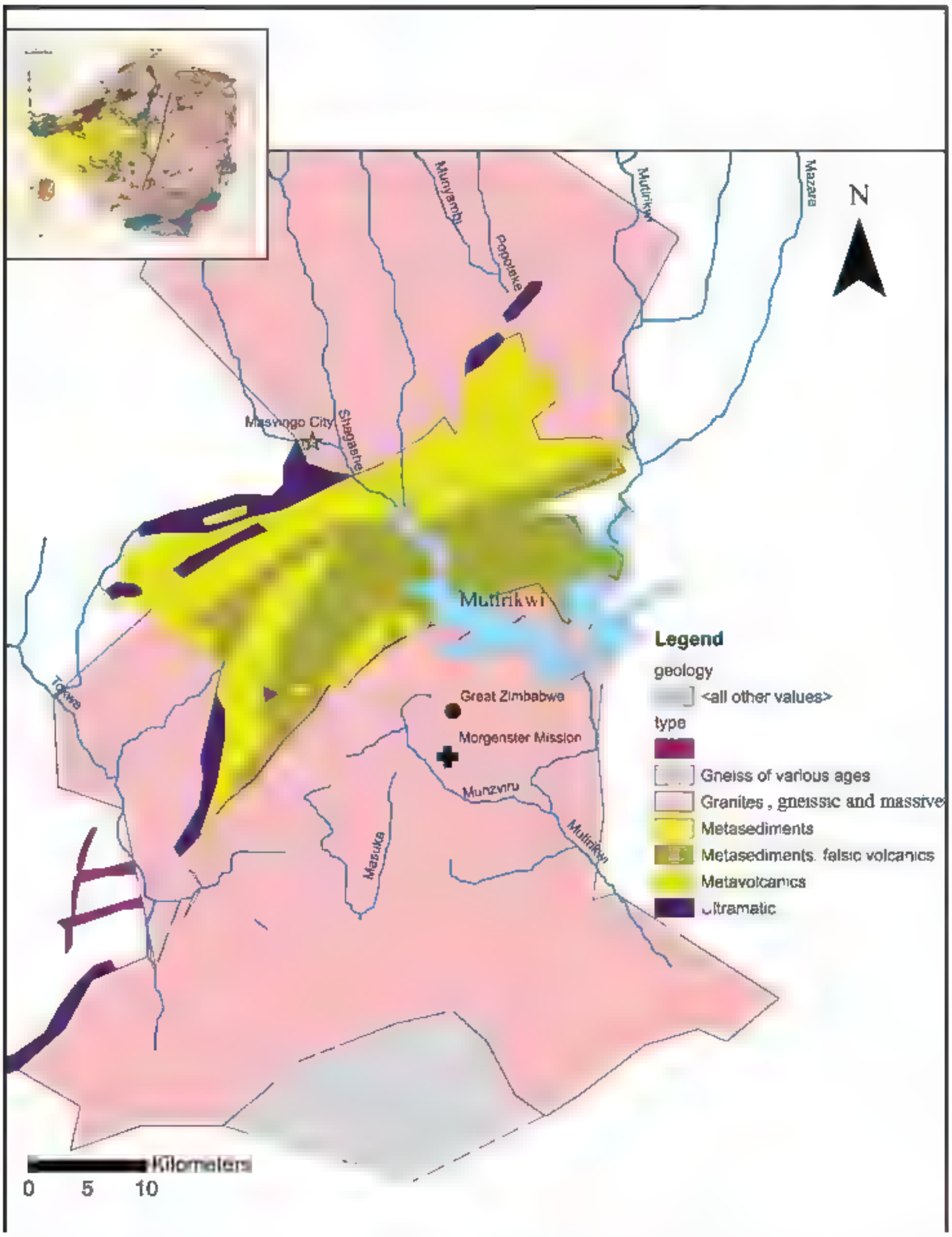



**Figure 8: Geological map of Zimbabwe (Source: Modified from Geological Map of Rhodesia, Surveyor General's Office, Zimbabwe).**

It is in this context that the geology of Great Zimbabwe is worth understanding. Geologically, Zimbabwe is considered one of the most ancient cratonic areas of the world. Most parts of the country are covered by granites and gneiss that intrude into basement, schists and volcanic rocks (Figure 8).

The granites and gneiss are common features of the South-East part of the country where Great Zimbabwe lies. Thus, Great Zimbabwe falls within the geological formation of South East Zimbabwe where the more easily weathered materials are covered by deep soils and the more resistant granite rocks remain exposed because the products of decomposition wash away as rapidly as they are formed. It is the abundance of these granite domes and outcrops that is more likely to have influenced the material that was used in the construction of the Great Zimbabwe ancient city. The walls that characterise the Great Zimbabwe site are built mainly from the local granite which is considered to be of early Archaean age (Gore et al. 2009). Intact exposed granites are a common feature and some rise above the ground as domes which can rise up to 200m. Pikirayi (2006) describes the geological environment of the plateau as characterised by remnants of geomorphological processes dating from the Precambrian times. The geology is mainly composed of intrusive granites and other igneous rocks. Prendergast (1979) also emphasised the presence of granites noting that most of the Highveld, Great Zimbabwe included, is typical Archaean granite. Another geological characteristic of the Great Zimbabwe area is the presence of older metamorphic rocks forming the schists/greenstone belts, found in-between the granites. It

is in these greenstone or schists where most of the gold mines are located (Hollaway 1997) This geology thus has a bearing on the underground water.

*Underground Water of Great Zimbabwe*

The geology around Great Zimbabwe allows for temporary streams. A combination of the granite and the decomposed soils allows for streams to disappear into the former and appear downstream in the later The geology of an area determines the occurrence of groundwater There is therefore a correlation between the type of geology and the patterns of underground water's availability. The occurrence of groundwater in areas of crystalline basement in Africa and Asia can often be related to the presence of secondary porosity in the form of fractures (Greenbaum 1986: 1). One characteristic of the study area involves temporary streams which are channels that lack surface flow during a certain period of the year (McDonough et al. 2011: 259). These streams disappear and re-appear downslope. These temporary streams flow as underground streams and reappear downstream as springs and/wetlands The scenario is owed to the underground geology of the area, where the granites underneath are composed of cracks, hence water gets into these cracks only to reappear downstream. This process is usually a result of the disconnection of the ground water caused by an unsaturated zone (Brunner et al 2009). Underground water occurrence is one of the key issues for the present study, and is analysed in Chapter 5

According to Greenbaum (1992), the movement of the groundwater is structurally controlled and confined to the weathered overburden due to the heterogeneous nature of the Zimbabwe Craton. When the rock develops some fissures, it becomes susceptible to weathering leading to the development of weak areas which are good sites for borehole sinking (Greenbaum 1992: 77). Small water reservoirs which collect runoff from the granite outcrops are a common feature of the hydrology of Great Zimbabwe. As postulated by Greenbaum (1992), to access this ground water, wells are often located adjacent to granite outcrops where soil and rock formations are conducive for sub-surface water collection Although the fissures or fractures start as compressional shears, they are the ones that provide avenues to groundwater. There are also a number of subsurface streams in the Great Zimbabwe area. Davies and Burgess (2013) assert that the common scenario in Zimbabwe is that evaporation exceeds rainfall, a situation which threatens underground water supply Accordingly, the underground streams at Great Zimbabwe are also affected by evaporation

***1.2.5 The Climate of Great Zimbabwe***

The Great Zimbabwe area falls within a semi-arid to savannah type of climate (Davies and Burgess 2013) with rainfall concentrated between November and March. The climate is tropical across most of south-eastern Zimbabwe. Great Zimbabwe climate has been well documented (see Bannerman 1982; Pikirayi 2006; Pikirayi et al. 2016). Great Zimbabwe falls within what Bannerman (1982) refers to as the Bikita/Ndanga Morgenster plateau, which is well watered and, unlike most of the country where the rainy season ends around March, here rainfall persists into April or May. Great Zimbabwe is characterised by dry/cold winters and wet summers As stated by Pikirayi (2006: 34), the climate at Great Zimbabwe is tropical which brings cool to cold dry winters and hot, wet summers. Mean annual rainfall ranges between 800-1000mm per year, of which 15% of this falls during the dry months between April and September (Bannerman 1982: 2).

The weather however varies depending on the area It is important to note that Great Zimbabwe receives a significant amount of drizzle and light rain, locally termed '*guti*' (Bannerman 1982; Sinclair 1987; Pikirayi 2006). This '*guti*' is highly localised as the intensity of this phenomena changes drastically a few kilometres from the site. Bannerman (1982) quantifies the distance at which climate differs to a little more than two hours walk from the Great Zimbabwe site. The environment which includes the granitic outcrops and the mountainous landscape around Great Zimbabwe modifies the rainfall leading to relief or orographic rainfall. Mountains are known for altering precipitation patterns (Smith 1979; Barros and Lettenmaier 1994; Roe 2005; Roe et al. 2003; Anders 2008). Orographic influences on precipitation occur due to rising and descending atmospheric motions forced by topography As Bannerman (1982) puts it, the effect of this orographic rainfall in the Great Zimbabwe area is drizzle, locally known as *guti*, which brings rain even when the Inter-Tropical Convergence Zone (ITCZ) migrates northwards (Bannerman 1982: 2). It has been observed that the sharpest climatic transitions on the earth's surface are a result of orographic effects (Minder and Roe 2014). The presence of *guti* around Great Zimbabwe makes the area conducive for agriculture, hence even in times of drought, the area still receives harvests. According to Bannerman (1982), droughts may occur but the effect in this area would be less severe than the surrounding lower areas. In spite of this, the occurrence of droughts even during the time when Great Zimbabwe was occupied cannot not be ruled out completely. However, the available palaeoclimate sequences are at a regional scale and sometimes present contrasting scenarios. There are no local proxies for past climate at Great Zimbabwe to date. There are only 'indirect' proxies to the climate and Chikumbirike (2014)'s data on charcoal from the site is an apt example. The data is on the various tree species that were growing at Great Zimbabwe, and provides insights into the plant growing conditions and by inference potential climatic conditions supporting plant growth. Pikirayi (2006) suggests that famines such as droughts could have led to population stagnation which in turn led to the demise of the ancient city. Even though drought occurrences have been recorded, it has been observed

that Great Zimbabwe is generally a well-watered 'island' surrounded by comparatively drier country In cases of droughts, mitigation measures were in place in case of such scenarios. Pikirayi (2006) hypothesised that in some instances, drought resulted in the complete abandonment of certain regions. With regard to the period of Great Zimbabwe's occupation, Tyson and Lindesay (1992: 271) point to a generally cool period (Little Ice Age), with a warmer episode recorded from 1500-1645.

***1.2.6 Vegetation***

The vegetation of Great Zimbabwe has perhaps the best datasets from past and recent researches on both present and archaeobotanical assemblages (see Bannerman 1981; Chikumbirike 2014). The vegetation of Great Zimbabwe and its surroundings comprises mixed savannah woodland, composed of Brachystegia (*miombo)*, Colophospermum (*mopane)*, Acacia and numerous grass species *Miombo* and acacia grow in the highlands, while *mopane* is mainly confined to low altitude river basins and dry south-western plateau margins These tree species are found south of the built-up area at Great Zimbabwe. Chikumbirike (2014: 174) observed that Great Zimbabwe and its environs are mainly characterised by *miombo* woodlands which comprise several vegetation of the families like *Fabaceae,* subfamily *Caesalpinoideae* particularly *Brachystegia, Julbernardia globiflora* and *Isoberlina*. The major characteristic of the vegetation of Great Zimbabwe is, however, the presence of secondary vegetation. According to Bannerman (1982), species such as *Celtis africana, Trema orientalis* and *Bridelia micrantha* which are present at Great Zimbabwe point to altered environments. In line with the presence of secondary vegetation is also the increase in the diversity of species at Great Zimbabwe. Chikumbirike (2014) highlights the difference in current vegetation and those identified in early documents and concludes that the only place where there used to be dense vegetation at Great Zimbabwe was the Great Enclosure. The changes observed in the present vegetation have been attributed to land-use and partially to the colonial administrative regime Besides the indigenous trees mentioned above, there are also exotic trees like *Lantana camara, Citrus limon*, *Jacaranda mimosifolia* and *Eucalyptus sp* (introduced from Australia). Some scholars have argued that the different management regimes at Great Zimbabwe World Heritage site could have promoted the speedy re-growth of the woody vegetation at Great Zimbabwe (Chikumbirike 2014: 181). Among the programs that are attributed to administrative regimes are the eradication of L*antana camara* and *Eucalyptus* stumping in the 1990s. Together with the planting of indigenous trees in the area that was once cleared to pave way for a golf course, this boosted the re-growth of indigenous trees at Great Zimbabwe.

*The Miombo* ecosystem has been occupied and utilised by both human beings and animals as this vegetation has medicinal and therapeutic properties (Chidumayo 1997; Augustino et al. 2011). The vegetation supports the growth of mushrooms as well as fruits According to Chikumbirike (2014), some tree leaves are cooked and consumed as relish. *Miombo* have local and regional, if not global, significance. For example, some of the major rivers in southern, central and eastern Africa such as the Zambezi, have their sources in areas covered by *miombo* woodlands The *miombo* woodlands play a role in influencing climate (Nicholson et al 1990, Hoffmann and Jackson 2000) Closely related to the study is the impact of *miombo* on the hydrology Chikumbirike (2014) gave an example of *dambos* (swampy or marshy areas), a distinctive feature of *miombo* regions that is found in seasonally waterlogged and shallow valley depressions. One of the reasons for the occurrence of *miombo* woodlands is their ability to adapt to minor environmental changes (Byers 2001)

The farming activities by Bantu speaking people which extend over a period of 1600 years are believed to have contributed to the status of current vegetation on the escarpment in general (Bannerman 1982: 5). Besides the *Brachystegia* woodland at Great Zimbabwe, there are some occurrences of *Vapacacirkiana* (muzhanje) which Bannerman (1982) attributes to the high moisture content in the area. Grasslands, characterised by *Hyparrhenia* species have been recorded at Great Zimbabwe and their occurrence has been attributed to fire and farming activities (Bannerman 1982). Chikumbirike (2014) has done some environmental reconstruction of the Great Zimbabwe period, and has observed that the paleovegetation of the site is close to the prevailing vegetation, which reflects a savannah grassland and tree biomes. He also points to a diversity of species found at Great Zimbabwe which he attributed to the management systems of the site. A close relationship between the natural environment and the site has since been established (see Garlake 1978; Pikirayi 2006; Chikumbirike 2014)

***1.2.7 Land-Use***

No particular farming activities are taking place in the area that was declared a National Monument. Occasionally, domestic animals from the nearby villages stray into the monument to graze especially during the dry season, when much of the surrounding villages would have dried up. This is in spite of the fact that there is an agreement between the local communities and the management at the site that domestic animals are not allowed to graze within the monument area

There are also several other programmes that are in place to protect the monument against veld fires and stray animals among other threats. Among these strategies is the fence that was once erected around the monument boundary. The fence was vandalised a few years ago leaving the monument accessible from various directions. One of the reasons why the National Museums and Monuments of Zimbabwe (NMMZ) has been reluctant to re-fence the monument is the argument that fencing the monument alienates local communities from their heritage. Consequently, a more inclusive management strategy has been put in place where a committee comprising members

of the local community and NMMZ staff was set up so as to ensure a harmonious relationship between the communities around the site and NMMZ

Although there are no agricultural activities permitted within the monument, there is evidence suggesting that some agricultural activities could have taken place within the monument in the past. For example, Pikirayi et al (2016) argue that the wetlands within the Great Zimbabwe monument were once cultivated The absence of a wooded environment at Great Zimbabwe except in the Great Enclosure is perhaps an indication that the land was at one point constantly used particularly for cultivation by the communities who were residing close to the site, the Nemanwa and Mugabe communities (Bannerman 1982).

**1.3 Research Aims and Objectives**

Against the given physiographic background, the study aims to explore the centrality of water in the day-to-day lives of the people who inhabited Great Zimbabwe. To achieve this, an ethno-historical approach as well as GIS tools are employed. Specific aims included mapping the hydrological patterns of tributaries and processes, and the water flows and to delineate watersheds as well as document rainfall patterns at Great Zimbabwe. Understanding the various water variables is supposed to shed light on the role of this resource in the rise as well as the demise of the ancient city of Great Zimbabwe. Through modelling spatial processes, an insight into the features such as the *dhaka* pits and their distribution within the site is obtained The study fits within the broader project of investigating the collapse of ancient societies in Africa (Pikirayi 2012). The broader project objectives at Great Zimbabwe involve a documentation of events connected to the past hydrological history and rainfall activities in the area, and connect these events to the cultural chronology of the site (Pikirayi 2012). The major focus of this study is to understand the salience of water as a resource in the development as well as collapse of Great Zimbabwe. It also analyses the interface between water and space The use of space is explored using modelling tools offered by GIS. It is within this broader project that the following research questions are raised for this study:

1. What were the water sources of Great Zimbabwe?
2. How was water managed at Great Zimbabwe?
3. How was the built environment related to water sources and channels?
4. How was the site located with respect to water, subsistence agriculture and other resources?
5. How was space utilised at Great Zimbabwe?
6. What role did water play in the demise of Great Zimbabwe?

**1.4 Research Problem**

The research addresses the need to understand the role played by water resources in the development and demise of ancient cities such as Great Zimbabwe. This need emanates from the idea that ever since research started at the site, no scholar has attempted to look at this precious resource, particularly its contributions in shaping the socio- political events of the time. In the process of understanding water related processes that shaped the distributional patterns at Great Zimbabwe, the use of space is also brought to light. Through analysis of water resources and their management, the carrying capacity of the site is also examined.

Beginning with early archaeological research at Great Zimbabwe, archaeologists have been preoccupied with understanding the nature and significance of the magnificent stone walls and other features as well as establishing the identity of the builders of the ancient city (Bent 1893b, 1895; Hall and Neal 1904; Hall 1905a; Caton-Thompson 1931). Consequently, a lot of academic research has concentrated on establishing the identity of the builders and the significance of the various features as the expense of understanding the significance of critical resources for the sustenance of the city, especially water.

A number of elements makes up a complex system in general, among them, water management systems.The complexity of cities is emphasised by Crouch (1996), who argues that a city is made up of various systems. These systems include government, defence, food supply and water management. These elements that make up a complex system have to be viewed in relation to each other hence the argument that 'viewing these in a city as singular items arranged in chronological series […] will be a great misrepresentation of facts' (Crouch 1996: 233). In spite of the importance of water in the development of ancient cities (see Brady and Ashmore 1999, Haug et al. 2003; Gates 2011), archaeologists are still to establish the role of water resources in the development of Great Zimbabwe as a city and its demise. Closely related is the establishment of the carrying capacity of the site using available resources. Population figures ranging from 10000 to 20000 people have been suggested as the maximum number of people who may have inhabited Great Zimbabwe during its peak These estimates, however, do not take into account the role that water played in determining the carrying capacity of the city.

Taking advantage of the developments in spatial analysis, in particular, the use of Geographic Information Systems (GIS) which now offer cutting-edge techniques for analysing the flow of water (Barton et al. 2010), and help design the operational requirements of different water management systems, the study examines the role water could have played at Great Zimbabwe. A major gap which this research tries to fill is whether Great Zimbabwe's location was influenced by the availability of adequate water resources, as well as other resources related to water such as suitable agricultural land, and if so, what role these could have played in the day to day lives of its inhabitants

The interpretation of the use of space at Great Zimbabwe can be traced from the 1980s (Huffman 1981, 1984, 1996a, 1997a; Sinclair 1987, 2010; Sinclair and Petren 1999). Sinclair and Petren (1999) for example, mainly use soil analysis to delimit the site. They argue that an analysis of both 'activity' areas and the 'open' spaces can help in reconsidering the cognitive maps of the site produced by Huffman (1981, 1984, 1996a). Huffman's models (see discussion in Chapter 2) have been used not only at Great Zimbabwe but at other stone structures in the country and in the region. Critics of Huffman's models mainly focus on the ethnographic approach used in coming up with an interpretation of the site (Beach 1997, 1998; Hall 1997; Collet et al. 1992; Chirikure and Pikirayi 2008; Pikirayi and Chirikure 2011; Chirikure et al. 2014) According to Collett et al. (1992), Huffman uses a structuralist approach that provides a social analysis for the whole site. No further scientific study has been done on the use of space at the site since the exploratory works of Sinclair (1987, 2010). This study, therefore, takes a scientific approach by using GIS tools to understand water resources around Great Zimbabwe and in the process gaining some insights into the use of space at the ancient city. GIS and other alternative methods are important tools in understanding the water resources and how these could have shaped the use of space at Great Zimbabwe.

An analysis of the water resources at Great Zimbabwe sheds light on how the city was inhabited and also some of the factors that led to its ultimate demise. In this context, among the theories that have been brought forward to account for the collapse of Great Zimbabwe, is the depletion of resources around the site (Garlake 1978; Pikirayi 2006) Since water is one of the important resources used on a daily basis, it is possible that its depletion may have contributed to the demise of Great Zimbabwe An examination of the relationship between water sources and the built environment can, therefore, contribute towards our understanding of Great Zimbabwe as a lived city

One of the reasons why archaeology still lags behind other disciplines in terms of support from governments and local communities is that most people view archaeology as a discipline irrelevant to the needs of contemporary societies. This study tries to address this challenge by looking at how present communities can benefit from understanding the ways in which ancient cities exploited their resources. There are many examples across the world showing that several modern cities were simply built on the same location as ancient ones Examples include Alexandria and Cairo in Egypt, Lisbon in Portugal, Athens in Greece, Damascus in Syria and Rome in Italy among others. Modern urban planners, therefore, have a lot to learn from how ancient cities were sited and planned. More importantly, an understanding of the way these ancient cities managed and distributed resources such as water can help inform modern urban planning (Sinclair et al. 2010).

## 1.5 Organisation of the Book

This book is organised into 7 chapters. Chapter 2 reviews the literature on Great Zimbabwe and other ancient cities. In particular, it focusses on the use of space and the centrality of water in the sustenance of ancient cities. It acknowledges that although Great Zimbabwe has been given scholary attention for more than a century, there has been a dearth of critical inquiry into the subject of water and its importance to this site. In addition, there also has been limited research on how water management interfaced with the use of space. The chapter locates the present study within the broader archaeological and anthropological studies of ancient cities. In particular, it engages with archaeological literature that deals with water engineering, water management and the interface between water and the built environment. The chapter also examines archeological works that have deployed various tools in spatial archaeology to understand water and the use of space.

Chapter 3 engages with the theories in which the research is framed. The research is mainly located within landscape archaeology and deploys GIS tools to understand the use of space. The chapter also evaluates the various methods employed in the study. Data gathering techniques which include archival research, ethnographic enquiry and archaeological surveys are examined. The chapter examines how archival research provided a basis for the research, offering infromation on the land-use history of the site of Great Zimbabwe. Ethnographic and archaeological surveys are some of the methods that were used in data gathering. For data analysis, the chapter discusses GIS and remote sensing tools that were used in the study. In particular, hydrological modelling and cost surface analysis are discussed in great depth as these are the main GIS analytical tools that were employed.

Chapter 4 examines the data gathered mainly from archival sources and ethnography. Results of the survey are also presented in this chapter. The study deploys a number of data gathering methods which include archival research, ethnographic research and archaeological survey. The chapter also examines known and potential sources of water at Great Zimbabwe. It alsoexamines issues on current water management in areas around Great Zimbabwe.

Chapter 5 uses hydrological modelling to examine the catchment characteristics of the area. The chapter also examines the area's catchment characteristics. The hydrological modelling takes two levels of analysis: the regional level, which analyses the broader catchment beyond the built up area, and the local level which concentrates on the built up area. At the local level, hydrological modelling is used to determine the relationship between individual structures at Great Zimbabwe and water channels.

Chapter 6 presents results of modeled movement patterns within the Great Zimbabwe site with respect to the fetching of water. The chapter presents the results of a cost surface analysis of the site. The cost surface analysis included the

creation of least cost paths, with focus on the possible routes that could have been used to carry water from the various known and potential water sources The chapter's main concern is to develop a space syntax for Great Zimbabwe, focussing particulalry on the interface between water and the built environment

Chapter 7 discusses the results from ethnographic surveys, archival research as well as the results from the different analytical procedures that the study deploys The chapter also provides a conclusion where a synthesis of the main ideas is presented. The conclusion emphasises the centrality of water and how water could have shaped the interactions in the ancient city.

# 2

# Literature Review

## 2.1 Introduction

There exists a large and ever growing corpus of work on Great Zimbabwe from antiquarians, professional archaeologists, anthropologists and historians among others. This, of course, gives the false impression that Great Zimbabwe has been 'over-researched' and there is nothing much to add. However, recent research is beginning to open up new research trajectories that engender more critical studies of Great Zimbabwe. The chapter examines this large corpus of works that exist on Great Zimbabwe. In particular, it analyses various scholars' interpretation of the use of space at Great Zimbabwe as well as the centrality of water in the sustenance of the city. In examining literature on water, reference is also made to other ancient cities in the world with a focus on their interaction with water resources.

## 2.2 Historiography of Research at Great Zimbabwe

Great Zimbabwe is one of the few sites in southern Africa that have received considerable archaeological and athropological research (see e.g. Bent 1893a, 1893b; Hall and Neal 1904; Hall 1905a, 1905b,1907; Caton-Thompson 1931; Robinson 1959; Whitty 1961; Garlake 1973, 1978; Huffman 1982, 1984, 1996a, 2010a; Fontein 2006; Chirikure and Pikirayi 2008; Chirikure et al. 2013, 2014, 2016). Research done so far can be divided into a number of phases. The first phase was characterised by enthusiasts and amateur archaeologists whose unscientific methods of enquiry amounted to treasure hunting. This led to massive destruction of the site. These early researchers were driven by the desire to know the builders of the Great Zimbabwe and to justify the assumption that the city was built by foreigners (Bent 1893; Hall 1905a, 1905b; Hall and Neal 1904). The earliest archaeological research at Great Zimbabwe was commisioned by the British South Africa Company, with the aim of disqualifying 'Africans' as possible authors of the site. Works by Theodore Bent (1892) and Hall and Neal (1904) all placed emphasis on the foreign origins of Great Zimbabwe. Eventhough the major focus was on the builders of Great Zimbabwe, these early scholars also highlighted a number of research problems which subsequent scholars have attempted to address. For instance, Hall (1905b) highlighted the absence of burials related to the Great Zimbabwe establishment, and pointed out that, 'in some cases [places] as far as ten miles from Zimbabwe have been systematically searched in the hope of discovering the burial place of the old gold-seekers' (Hall 1905a: xvii). Of relevance to the current study is the observation that was also made by Hall (1905a: 280) of the water-holes mainly to the west of the Hill Complex. The mentioned water-holes refer to the ones known locally as the *'dhaka pits'*. For early researchers, these water holes were 'artificial' and had been dug for the purpose of holding water or to create wells This is a claim which has never received scholarly attention, hence this study also endeavours to explore the nature and possible interaction of these with other features on the landscape In spite of the various insightful observations made, the weakness of all these studies was that they were mostly done by amateur archaeologists and treasure hunters whose major aim was to prove that Great Zimbabwe had been constructed by foreigners

One of the earliest systematic studies of Great Zimbabwe was done by Randall-McIver (1906) Randall-McIver is credited for initiating research on the African origin of the Zimbabwe Culture sites. From his analysis, he argued that from architecture to objects found at the site of Great Zimbabwe, there were no traces of Oriental or European style (Randall-McIver 1906: 83). In addition to this, Randall-McIver (1906) also attempted to interpret the use of space at Great Zimbabwe using the material discovered at the site For Randall-McIver (1906), the Great Enclosure was the royal residence and the valley enclosures were meant for the rich merchants who were dealing in gold He also argued that Great Zimbabwe was only a distributional centre with no major primary activities such as mining and farming. The western enclosure of the Hill Complex was equated to the Great Enclosure, hence it could have served as the king's residence (Randall-McIver 1906: 77)

The early 20th century saw a more systematic and objective study of Great Zimbabwe. Caton-Thompson's (1931) work became a turning point in the archaeology of Great Zimbabwe as she concluded that Great Zimbabwe was built by indigenous people. Subsquent work by scholars such as Whitty (1961), Summers (1963), Robinson (1959) and Garlake (1973) used local masonry skills, pottery sequences as well as radio carbon dates to further cement the argument that Great Zimbabwe was built by locals

The origin of the the dry stone walls of Great Zimbabwe is an ongoing debate despite the huge amount of available archaeological evidence which point to the indegenous authorship of the monument. The work of Mullan (1969), in which he argued for a foreign origin of the site, is an example of the continued debate on the authorship of Great Zimbabwe

Caton-Thompson (1931) is credited for coming up with a cultural sequence of the site which was synthesised by Garlake (1973), and Summers and Whitty (1961).

The period after Caton-Thompson's work up to the 1970s is characterised by research aimed at establishing chronologies where focus was on dating using ceramics and architecture, as well as classification of the artefacts (Caton-Thompson 1931; Robinson 1961; Summers and Whitty 1961). From the established dates, the western enclosure of the Hill Complex and the walls in the valley are the earliest and the Great Enclosure is considered to have been constructed last (Whitty 1961). It was only in the 1980s that issues of spatial patterning at Great Zimbabwe began to be considered (Huffman, 1981, 1984; Sinclair 1987). It is, therefore, the aim of this book to contribute to the existing knowledge on the use of space at the site through analysing the interface between water and space using GIS tools.

### *2.2.1 Research on the Development and Demise of Great Zimbabwe*

Huffman (2000, 2009) links the development of Great Zimbabwe to Mapungubwe, a site in the Shashe-Limpopo area, on the South African side. Huffman (2000: 14) argues that Mapungubwe is a very important site, providing 'the earliest evidence for class distinction and sacred leadership in southern Africa'. Mapungubwe had developed intially as a result of intensive agriculture and surplus in trade wealth. Kim and Kusimba (2008) mention availability of good water bases in the areas that Great Zimbabwe, Mapungubwe and Bambandyanalo are located. According to Kim and Kusimba (2008), the state systems developed as a result of the elite's monopolisation of resources, among them well watered fertile pastures as well as other industries such as crafts. Until recently (Pikirayi etal 2016), there has not been any serious attempt to understand the centrality of water in the sustenance of the site. This study seeks to establish the importance of water as a resource in the fuctioning of the city as well as the implication of space and resources such as water

Scholars have emphasised the role played by external factors, especially long distance trade, in the establishment of the ancient city of Great Zimbabwe (Garlake 1973; Huffman 1972; Pikirayi 2001). Huffman (1972) is convinced that trade is more likely to have played a significant role in the establishment of Great Zimbabwe. Imports found at Great Zimbabwe such as the Arab and Kilwa coins, glass beads and Chinese porcelain are some of the evidence that is used to argue for trade as having played a significant role in the development of the city Pikirayi (2006) acknowledges the role of trade arguing that the rulers at Great Zimbabwe got their wealth from trade, taxation and also from gold mining.

Garlake (1970) highlights that there is an assumption that prosperity caused rapid increase in the population concentrated in the immediate area of Great Zimbabwe. A trend adopted by new archaeology is that cultural change is primarily a consequence of population growth rather than a trigger for growth (Glassow 1978). The intensive terracingof the Hill Complex and the rich material culture deposits in the valley initially suggested an increase in population (Garlake 1970)

In trying to account for the demise of Great Zimbabwe, Garlake (1970) suggests an inreasing population which strained the natural resource base. Among these resources are timber for firewood and huts, pasture land, game and soil which are argued to have been progressively depleted, resulting in minor crop and climatic failures (Garlake 1970). These could have disrupted the status quo in the society at a rate too fast to allow the society to adopt new social and economic strategies. This is supported by Pikirayi (2006), who uses an ecological explanation for the demise of Great Zimbabwe, specifically mentioning the large population which then placed pressure on firewood, and exhausted the soils, rendering the land agriculturally unproductive. Pikirayi (2006) argues that there is a possibility of environmental change resulting in turmoil.

In spite of the absence of direct evidence, the demise of several past African urban sites has been linked to drying climate between 1100 1400 AD such as Jenne-Jenno in West Africa, and Kilwa on the Swahili coast in Eastern Africa and the Great Lakes region (Tyson and Lindesay 1992; Huffman 1996b; Fagan 2008). Environmental degradation is thought to have led to political upheavals which later led to abandonment of these regions which could no longer sustain livestock and crop farming (Pikirayi 2006: 42) However, the case for Great Zimbabwe is different. There is evidence suggesting that the city flourished during this period of environmental stress only to decline when environmental conditions had improved. On the other hand, Pikirayi (2006) argues that although the environment could have played a role, there is a possibility that famine and epidemic diseases led to population stagnation, not necessarily climatic conditions. He also acknowledges that the settlement at Great Zimbabwe could have been influenced by the environment. Thus, if the environment played a role in the settlement choice of Great Zimbabwe, it is possible that the over-exploitation and depletion of resources thereof could have led to the collapse of the state

The decline of states in southern Africa appears not to have been tied to the environmental factors only but was also a consequence of social, economic and political mismanagement by the ruling elite Trade is often overlooked in such interpretations, but it impacted strongly on the physical environment. With reference to the Iron Age in the Darwendale area, northern Zimbabwe, Prendergast (1979) argues that the environment played a role in shaping the settlement pattern. He also observes that the soils that were suitable for cultivation were more populated than clay soils and areas such as wetlands were avoided. For the Darwendale area, Iron age 'settlements were concentrated along the main rivers where water, grazing lands and fertile vleis were abundant' (Prendergast 1979: 118). Examining the impacts of the environment on the African continent from 'Paleolithic' times, Summers (1960) discusses the inconsistency of the rainfall in

Zimbabwe. Subsequently, if there is a historical record of rainfall inconsistency, the environmental theory to the collapse of Great Zimbabwe could be true.

### *2.2.2 The Use of Space at Great Zimbabwe*

Apart from the authorship of the site, the other issue that has stirred so much scholarly debate has been the use of space and symbolic meaning of different features The stone walls of Great Zimbabwe have generally been accepted to represent the ruling class, a symbol of political authority and a highly-stratified society (Garlake 1982) The 1980s saw scholars such as Huffman (1981, 1982, 1984, 1996a) using ethnography to interpret symbolic structures and the use of space at Great Zimbabwe Huffman's (1981) interpretation of the site in an article 'Snakes and Birds: Expressive space at Great Zimbabwe' remained the only such work for some time. Huffman's (1981) model on the use of space at Great Zimbabwe was based on the idea that social structure can be deduced from arrangement of structures He argues that the use of space is a cultural variable and as such the physical remains can be regarded as a society's 'expressive space'. Using ethno-historical accounts where chiefs are associated with hills, Huffman (1981) interpreted the Hill Complex as the king's residence. In particular, the western enclosure of the Hill Complex was interpreted as the residence of the King because of the number of residential remains that were found in the enclosure (Huffman 1984: 595) Among these remains are the house floors that are found in this enclosure In ethno-historical accounts, mountains represent high status hence there is a close connection between hills and political power (Huffman 1981: 133). This was combined with evidence from the material culture recovered from the Hill Complex where items such as hoes and spears recovered from the western enclosure of the Hill Complex are taken as royal paraphernalia. The eastern enclosures in the Hill Complex have yielded ceremonial items such as the soapstone 'zimbabwe birds' and the absence of residential remains made them to be regarded as religious centres. The high concentration of huts at the base of the hill is taken as relating to commoners' residence which can be distinguished from the hill (king's residence) Whereas the ruling class were living inside the enclosures, the commoners lived outside of these enclosures. This commoner residence interpretation of the areas outside the enclosures was supported by 'ordinary utensils' that were recovered during excavations in these areas (Huffman 1984: 196)

Huffman's interpretation considers the landscape in totality as he makes mention of an empty space between the Hill Complex and the valley ruins. The empty space in Huffman's model is possibly an assembly point (*dare*) where elders would come together to discuss issues affecting the society (Huffman 1981, 1984). Whereas the Hill Complex and the open space represent the male places at Great Zimbabwe, the valley ruins and the Great Enclosure represents the female areas (Huffman 1981: 134). The most significant architecturally, the Great Enclosure, represents the senior wife's residence (*imbahuru*)

In addition, Huffman (1984) argues that there are discrete locations at Great Zimbabwe where certain cultural activities are limited to specific locations He however admits that the model does not 'satisfactorily explain the precise function of the most impressive building in the town' (Huffman 1984: 593). His ideas were synthensised in his 1996 book, *Snakes and Crocodiles: Power and Symbolism in ancient Zimbabwe* (Wits University Press) Using Venda ethnography, Huffman suggested that there is high likelihood that the Great Enclosure was used as an initiation centre. In the book, Huffman (1996a), the Great Enclosure, was an initiation centre (*domba*) where young girls and boys were initiated into adulthood, an area which was overseen by women. The process involved boys and girls being initiated into adulthood through some form of lessons where figurines were used as teaching aids These lessons were done at the Royal wives' residence. Huffman argues that the king's first wife resided in one of the enclosures in the Valley ruins, the Renders Ruin (Central Ridge ruin). In the book, Huffman (1996a) also asserts that the stone walls represent royal residences and asserts that the king was able to maintain the status quo by means of sacred leadership Huffman (1996a) interpreted the back of the Hill Complex as the ritual hub, where ritual activities were conducted He maintained that the Eastern Enclosure, where most of the soapstone birds were found represented a ritual centre and it was also in this enclosure that the court was held

However, Huffman's model was questioned by many scholars to the extent that in 1997, a review feature appeared in the *South African Archaeological Bulletin* dedicated to reviewing the book. Scholars from different academic backgrounds challenged Huffman's interpretation of the use of space at Great Zimbabwe, his use of sources and deployment of Venda ethnography to interpret a Shona site. The feature also included Huffman's reply to the issues that had been raised by the different scholars. Beach (1998) questions Huffman's structuralist approach, use of cognitive archaeology and the use of ethnographic data. Huffman (1996a) acknowledges that the town was not occupied once but successively for a period of more than 150 years although his model gives the impression that the town's construction was a 'once-off' event. Great Zimbabwe was constructed and occupied over a long period of time which means that the use of space and the meaning of some symbolic structures changed over time. Beach (1998) argues that Huffman's reconstruction of the cognitive aspects of Great Zimbabwe was 'based on misunderstood documents, dubious oral traditions and inappropriate comparisons to arrive at a picture of a city that was essentially static in its use of space' (Beach 1988: 47).

Bourdillon (1997: 127) criticises Huffman for his failure to adequately explain the 'symbolic system' he used to interpret space at Great Zimbabwe. He argues that having

symbols that are common between two different groups (Shona and Venda) does not imply 'sameness' in every aspect (Bourdillon 1997: 127). Bourdillon also points out that one of the things that are glaringly missing from the interpretation suggested by Huffman (1996a) are spirit mediums whom, he argues, are so prominent in Shona culture and in ethnographic as well as historic accounts. In the same vein, Denbow (1997:127) emphasises the point highlighting that even among the Shona themselves, symbolism in rituals can have diverse significances. This casts doubt on the usefulness of Venda ethnography in explaining the use of space at a Shona site. Citing the case of the inconsistency in the interpretation of east and west areas at Great Zimbabwe and at Danangombe, Denbow (1997) argues that all zimbabwe type sites could well be explained using Huffman's model.

Like Beach (1997), Hall (1997) also criticises Huffman's (1996a) use of Shona oral traditions, especially his assumption that the people had not changed for more than five hundred years. For Hall (1997), both Great Zimbabwe and Mapungungwe and all their symbolic features were made in a period beyond the reach of oral traditions which Huffman tries to use. Hall (1997) argues that Huffman's interpretation is biased towards the need to fit his 'classic' structure of binary opposites of 'male-female', 'west-east', 'hill-valley'. This issue is taken up by Lane (1997) who questions Huffman's (1996a) structuralist approach by arguing that in some instances, male and female statuses were at par and that there were also instances where there was no distinction between male and female space. The wholesome transfer of ethnographic data to archaeological phenomena is another area of contention. Lane (1997) emphasises that there is no guarantee of similarity between the ethnographic and archaeological data. Still on the methodology, other issues relate to the sample that Huffman used to make generalisations about the Shona people. Lane (1997) is of the opinion that a sample of 10 informants whom Huffman consulted in researching for the book is too small. Also, the lack of information on the profiles of the informants worsens the sampling procedure. Huffman is also taken to task when he highlighted that he would use ethnographies from different cultural groups, the Tswana, Pedi, Sotho and Shona (Lane 1997). Lane's major argument is that the same symbol can mean different things to different groups. Huffman's use of Venda ethnography to explain a site which is attributed to the Shona is based on the premise that groups of people who share the same world view are likely to organise their settlements in the same manner. Pikirayi (1997) argues that this thinking does not take into cognisance the effect of the environment in shaping settlement patterns. Pikirayi (1997), making particular reference to Huffman (1996a)'s symbolic interpretation of the herringbone design on divine dices (*hakata),* maintains that the interpretation is not very clear. Rather than appearing on the divine dices, Pikirayi (1997) argues that the herringbone decoration is mainly found on ceramics. These arguments indicate misuse of ethnography in the interpretation of Great Zimbabwe.

One of the major weaknesses of Huffman's (1996a) interpretation of the use of space at Great Zimbabwe is the assumption that the site was occupied at once (Pikirayi 1997). This interpretation is not supported by architectural evidence. Architectural analyses as well as radiocarbon dates have indicated that the site was occupied successively over a long period of time, with building being a continuous process (Pikirayi 1997, Chirikure and Pikirayi 2008, Pikirayi and Chirikure 2011). It is quite evident that Great Zimbabwe was built over a long period of time and the use of space also changed over time (Pwiti 1997). In this vein, Pwiti (1997) highlights the need to incorporate cultural dynamism in the interpretation of these sites. Pwiti (1997) also questions Huffman's (1996a) argument that the Great Enclosure was used as an initiation centre. He observed that even among the Venda, no such investment is put towards the *domba* initiation rituals

In response to 'some' of the issues raised by the several scholars, Huffman (1997b) maintains his principal arguments by insisting on the need to use Venda ethnography to interpret Great Zimbabwe arguing that 'most of the chiefdoms predating the Singo-Rozwi claim to have come from what is now Zimbabwe' (Huffman 1997b: 140). Huffman also defends his use of Shona oral traditions by arguing that 'when asking his informants, he was not interested in the answers but in the logic of such answers' (Huffman 1997: 140). He also defends his thesis in the later publication he did with Murimbika (Huffman and Murimbika 2003) which also takes a structuralist approach to the use of space. In spite of the robust defence that Huffman (1997b) mounts against his critics, the reviewers exposed a number of weaknesses with his interpretation of the use of space at Great Zimbabwe as well as the methodology he deploys. By using space syntax, this study aims at understanding the locational importance of features. In particular, the study focuses on accessibility of water resources.

After a brief hiatus, debate on the methodology used by Huffman in his interpretation of the use of space at Great Zimbabwe has resurfaced (see e.g. Chirikure and Pikirayi 2008; Manyanga et al. 2010; Huffman 2011; Pikirayi and Chirikure 2011). Chirikure and Pikirayi (2008) call for an integrated archaeological research program on Great Zimbabwe so as to get new insights on the site. Since the publication of Chirikure and Pikirayi (2008), there have been serious academic debates which have prompted the need for more research at the site. This challenges the false impression in Zimbabwean archaeology circles that all avenues of investigating the site have been exhausted (Pikirayi and Chirikure 2011; Pikirayi 2013; Chikumbirike 2014). The subsequent works are in line with Garlake (1970) who had advocated for a continuous re-examination of interpretations of the site. Garlake (1970) argued that there was need for more excavations at the site. As more scientific aids of progressively greater precision are becomming available to archaeologists, new avenues of interpreting the site are emerging (see e.g Pikirayi et al 2016). It is within this call for a re-investigation of the use

of space at Great Zimbabwe that this study deploys tools in spatial analysis, in particular GIS tools, to examine how water as aresource could have shaped the pattern exhibited at the ancienty city of Great Zimbabwe.

### *2.2.3 Chronology*

Another area which has caught the attention of archaeologists has been the chronology of Great Zimbabwe. Recently, Chirikure and Pikirayi (2008) reviewed the existing chronology of Great Zimbabwe which was intially developed by Caton-Thompson (1931) and then redefined by Robinson (1961), Summers and Whitty (1961) and synthesised by Chipunza (1994, 1997) There are five periods of occupation at Great Zimbabwe, which have been radiocarbondated (Garlake 1970) Period I and II represent the time before the stone walls According to Garlake (1970), stone walling begins to appear in period III Period IV is characterised by increase in prosperity evidenced by massive stone walling, most spectacular in the Great Enclosure. The last period, which is Period V, is characterised by Karanga people living near the ruined stone buildings. The earliest monumental walls characterised by the P and PQ walls of the Western enclosure in the Hill Complex and those in the valley ruins are characteristic of Period III of occupation. A re-calibration of radiocarbon dates was also done which showed serial occupation of the site. This was used to question the assumption that 'different parts of the ruins were active at the same time' (Chirikure and Pikirayi 2008: 991). Chirikure and Pikirayi (2008), using evidence which suggests that the western enclosure of the Hill Complex and the Valley ruins are the earliest stone walls at the site, argue that these two parts of the site are contemporaneus It is, therefore, logical to say the first rulers at the site lived in the hill complex considering the less monumental nature of the valley ruins structures. Using the elaborate nature of the Q walling of the lower valley enclosures and the Great enclosure, Chirikure and Pikirayi (2008) suggest that political sucession was passed on, first,to an individual who was based at the Great Enclosure and later to the lower valley during Period IV of the site's occupation.

In revisiting the chronology of Great Zimbabwe, Chirikure et al (2013b), used Bayesian modelling, an approach in radiocarbon dating The approach produces an integrated interpretation by incorporating known information with current data. The integrated interpretation of the chronology of the site of Great Zimbabwe is necessary considering that most of the information and material had been lost during the plundering phase of the site by antiquarians Chirikure et al (2013b) used stratigraphies from Robinson and Summers' excavations (Robinson 1961; Summers et al. 1961). These stratigraphies were compared to the chronologies which had been developed based on imported materials such as glass beads and ceramics which can be dated historically. The Bayesian study indicated that Great Zimbabwe was occupied for a period of between 40 and 588 years (Chirikure et al. 2013b) The pre-stone walls period, marked by the presence of Gumanye pottery mainly in the Hill Complex, has made it difficult to determine the beginning of the stone walling at Great Zimbabwe. Bayesian modelling confirmed Robinson (1985)'s dates which place the start of the drystone building at the end of the 12th and beginning of the 13th centuries (Chirikure et al. 2013b: 869). The results of the Bayesian modelling put the inaugural boundary for the Hill Complex at AD 1100–1281, while that of the Great Enclosure is AD 1226–1383. The results of the study showed that the Hill Complex, Great Enclosure and the valley enclosures were built at different times This, therefore, questions the structuralist approach to the interpretation of the use of space at Great Zimbabwe. Chirikure et al. (2013b) argue that the various activities ascribed to different parts of the monument could have shifted over time. Chirikure et al (2014)'s work at Mapela, a site in the Shashe-Limpopo basin, has provided significant insights into the chronologies of the zimbabwe culture sites. According to Chirikure et al. (2014), once seen as insignificant site, Mapela has yielded K2, Transitional K2 and Mapungubwe ceramics as well as glass beads. These have been recovered in stratified and uninterrupted contexts which have allowed for reliable radiocarbon dating. The early dates for this site suggest overlap with Leopard's Kopje communities The Bayesian chronology also highlighted the overlap between Mapungubwe and Great Zimbabwe, thereby shaking the 'agreed' model of Great Zimbabwe having developed after Mapungubwe This is in syncronisation with some synthesised ideas by earlier scholars (Garlake 1973; Collett et al. 1992; Beach 1998), who had suggested that there was a shift of power from the Hill Complex to the Great Enclosure and subsequently to the Ridge ruins According to Collett et al. (1992), the Valley Ruins were the last to be settled after the Great Enclosure and the Hill Complex had long been abondoned. This is a significant departure from Huffman (1996b) who advocates for an interpretation of the site which disregards the fact that these structures were built at different periods

### *2.2.4 Great Zimbabwe's Material Culture*

In support of the idea of 'rulers changing residences', Chirikure and Pikirayi (2008) noticed a minor difference in the material culture that was discovered in the various places at Great Zimabwe which has made them to come up with the argument that there is no place within the site that was dedicated to specific activities. For Huffman's model to work, the material culture recovered should be 'place specific' (a certain materal culture being perculiar to a certain place) However, for Chirikure and Pikirayi (2008), there is not much difference in the material recovered from the Hill Complex and that from other parts of the site Materials with utilitarian value, those which have been labelled ceremonial objects as well as products of craft activities, have been discovered from the Hill Complex, the Great Enclosure, valley structures and the open spaces Pikirayi and Chirikure (2011) acknowledge the existence of patterns in the usage of space at Great Zimbabwe but emphasise that use of space could change Manyanga et al. (2010) argue that Huffman's model assumes the

sites such as Great Zimbabwe were pre-designed, built and occupied. The idea of delimiting cities, which is a functionalist approach, has also been questioned given that the urban-rural divide of pre-European urban centres in southern Africa was characterised by high integration and connectivity (Manyanga et al. 2010: 582)

Besides the use of cultural material, Chirikure and Pikirayi (2008) cite Mudenge (1988) who used the ethnographic Shona political structures to support their argument of shifting centres given that the Shona did not use the principle of premogeniture (sucession from father to son) in their succession system. Beach (1994) argues that most Shona use the principle of adelphic collateral succession. In the adelphic collateral succession is from the father to all the sons, starting with the first and then after all brothers have had their turns, it goes to the children in their order of seniority. Succession follows what are called houses (the lineages of the original brothers). In the adelphic model, succession is therefore to follow the order from 1 to 36 The adelphic collateral system results in conflicts and succession wars This is one of the reasons why the Portuguese often intervened in the Mutapa state's internal affairs (Mudenge 1998: 84). Chirikure et al. (2012) did a recalibration of Great Zimbabwe's radiocarbon dates using indigenous African philosophies and Bayesian modelling The results suggested that the urban centres (of the zimbabwe culture) may not have been part of unified hierarchical and sequential structures. Chirikure et al (2012) emphasised succession politics in explaining the Zimbabwe settlements situated on the plateau and beyond

Using the Shona cosmology and material culture, Chirikure and Pikirayi (2008) question Huffman's model, especially his claims that the valley ruins and the Great Enclosure were all meant for the king's wives (Huffman 1996a). The presence of metalworking slag in the valley ruins is seen as an indicator that males were also present in this area. Chirikure and Pikirayi (2008) also raised issues with Huffman's model particulalry the use of Venda ethnography arguing that Venda identity differs in many ways from the Karanga one Other concerns raised with Huffman's model relate to the argument that the Great Enclosure was a *domba* (an intiation centre). Chirikure and Pikirayi (2008) argue that there are usually temporary structures where initiation takes place, and this is unlikely to be reflected in the archaeological record, which is contrary to what we see in the Great Enclosure. It would be very unusual for such a gigantic structure to be built just for intiation purposes

### *2.2.5 Great Zimbabwe as a Landscape*

Besides Huffman's interpretation of the use of space at Great Zimbabwe, Sinclair (2010)'s work is critical in that it highlights the need to treat Great Zimbabwe as a landscape rather than a city composed of drystone walling Using spatial analysis, Sinclair (1987, 2010), analysed the development of Great Zimbabwe in terms of multi-scalar regional and local landscape. Sinclair (1987) did a territorial analysis of the Zimbabwe Culture sites and remarked that the spatial distribution is as a result of a number of factors. At an inter-site level, each site is unique hence no single spatial configurations should be taken as the only interpretive framework (Sinclair 1987: 162). Sinclair et al (1993) used site catchment analysis to argue that the main variables in the choice of settlement for Zimbabwe culture sites are proximity to permanent water sources and granite, a source of material used in the construction of the walls. Sinclair (2010) mapped wetlands (*dambos)* and swamps in the Great Zimbabwe area. His study is critical in highlighting the importance of water which is a resource that is capable of dictating how people manage their places. Sinclair (2010) also highlights the importance of the 'open green areas' at intra-site level spatial analyis According to Sinclair (2010), these were meant to mainatin an ecosystem and also provide food security (through gardening) In that regard, the 'gardens' can be viewed as an exhibit of the capacity of the system that was at the site to manage water. Using phosphate analysis, Sinclair (2010) argues that wetlands found within the confines of Great Zimbabwe were used for gardening From these works, the need to take Great Zimbabwe as a landscape with its natural and cultural features has since been emphasised

The environment shaped the settlement of Great Zimbabwe and nature supported the building of the town as reflected by the interwoveness of the natural boulders and the walls that are within the Hill Complex (see Manyanga et al. 2010). In this regard, the study analyses the interface between water and the built environment at Great Zimbabwe. Spatial layout is analysed in relation to economic as well as environmental parameters with particular reference to water availability. From this movement, patterns are configured and in the process, values are assigned to certain parts of the site. The need to use alternative methods to compare with Huffman's (1996a) cognitive maps of Great Zimbabwe is among the factors that led Sinclair and Petrén (1999) to use ground mapping as well as soil sciences to delimit the urban centre. This study employs ethnographic data and space syntax to understand natural and cultural processes that obtained during the occupation period of Great Zimbabwe.

Chirikure et al. (2016) point to a much more complex class relation between the Hill Complex (perceived royal residence) and the valley, particularly the open spaces (perceived as commoner residence). The excavations of the Great Zimbabwe Car Park Midden, located in the 'open spaces' by Chirikure et al. (2016), yielded material similar to that of the Hill Complex. Some of this material predates the architecture of the Hill Complex, questioning the chronology that places the Hill Complex as the earliest part of the site. Yielding similar material is taken to imply equal access to these 'precious' goods, hence disqualifying the royal-commoner relationships

Beach (1998) is among the first scholars to critique Huffman's model and also offer an alternative interpretation

of Great Zimbabwe. Drawing from the Shona political processes, he suggested moving chieftaincy in place of Huffman's (1996a) static role of the various enclosures Beach (1998) suggested that the first ruler was staying in the Hill Complex together with his wife and his close male companions, just like the situtation that obtained in the Mutapa state in the 1600s. Upon death of the ruler, a son already staying in the Great Enclosure takes over and does not necessarily have to move to the Hill Complex (Beach 1998: 57). After death of the second ruler, a third ruler is the one who re-occupies the western enclosure of the Hill Complex, a scenario that explains the presence of PQ and Q walling Chirikure and Pikirayi (2008) take into account the different occupation phases of the site Like Huffman's model, Chirikure and Pikirayi's (2008) interpretation is based on what was found in the various enclosures and the walls themselves. There is however, need to go beyond the built structures and consider the surrounding landscape A more comprehensive approach which has been intiated by Ndoro (2005) and considers the landscape in general is therefore fundamental. Accordng to Ndoro (2005: 49), 'the core of the Great Zmbabwe cannot simply be viewed as the architectural and archaeological feature' The current study therefore offers an opportunity to use alternative methods, specifically hydrological modelling and GIS, to explore meaningful social interactions that are gained from analysing the structures in relation to water and other resources.

With emphasis on the interdisciplinary nature of archaeology, archaeological researches have also taken various dimensions including heritage perspectives, ethnohistory and environmental studies. Some of these studies at Great Zimbabwe include Ndoro (2005), who from a heritage perspective, gives a managemnt history of Great Zimbabwe and the different factors affecting the site's stonewalled architecture. Ndoro (2005) indicates that even in heritage conservation, this heritage is intertwined with the use and control of other resources such as water, soil, forests and grasslands which have never been critically analysed (Ndoro 2005: 49). In this respect, the need to investigate water is not only for the benefit of the archaeological fraternity but extends to heritage managers as well

### *2.2.6 Custodianship of Great Zimbabwe as a Heritage Site*

Fontein (2006a, 2006b) takes another dimension, which focusses on the contestations of the Great Zimbabwe as a heitage site. Great Zimbabwe has been contested for a long time, with the Nemanwa, Charumbira and Mugabe clans claiming ownership of the site. These contestations have greatly affected the management of the site which should incoporate the owners of the heritage. The other area that Fontein deals with relates to the religious aspect of the site. The spiritual values of Great Zimbabwe are undermined in favour of other values like economic and educational ones and the result has been desecration of the site (Fontein 2006b)

### *2.2.7 The Multi-disciplinary Approach*

The diversity of research at Great Zimbabwe in the last decade is also seen in Chikumbirike's (2014) work. Using methods in geo-sciences, Chikumbirike's work is an attempt towards reconstruction of the environment at Great Zimbabwe. The major interest in the study was to establish the type of vegetation which was in existence during the occupation period (Chikumbirike 2014). Great strides have been made in understanding Great Zimbabwe from different angles. However, from the studies which have been done to date, water has not received much attention yet Great Zimbabwe was once a lived city, which like any other establishment, required water on a day to day basis. Thus the study focusses on water as a resource at this ancient city. The study employs GIS tools to examine the issues of accessibility with respect to water sources.

The first intiative in calculating the population of Great Zimbabwe during the occupation period was done by Garlake (1970) who achieved this by estimating the labour and time that could have been required to put up the structures. He argues that a considerable propotion of manpower and energy of the populace was employed in building the monument. He also argues that by 15th century, Great Zimbabwe had a substantial population which was dependant on subsistance agriculture. The very scale and permanence of the buildings that had been erected then rendered the society based at Great Zimbabwe unnaturally immobile.

## 2.3 Water and Ancient Cities: An Overview

One of the key factors necessary for human life and for a city to flourish is the availability of reliable sources of water. Barton et al. (2010) assert that water plays a critical role in all human societies, past and present. This is emphasised by Rogers (2013: 222) who argues that 'water is one of the value-laden substance in the past, as it is still today, and hence can never form a neutral or unproblematic element of the landscape or the settlement in it' It is within this context that Rogers (2013) has demonstrated the relationship between water and urban settlement development using the case of Roman cities. Ancient Egypt was referred to as the 'Gift of the Nile' by early Greek philosophers because of the importance of the Nile River in the development of the Egyptian civilisation (see Griffiths 1966). It is against this background that this study specifically focuses on the centrality of water on the development of Great Zimbabwe.

Water has been critical in the establishment of ancient cities. Harrower (2010) argues that from small bands of foragers, pastoralists, and village agriculturists, to states and civilisations, water accessibility and management played a crucial role in sustenance and social life throughout the ancient world. The scarcity of water and the need to manage it have led scholars to argue that 'water is the mainspring of civilisations' (Hassan 2003, 2011; Cosgroove 2003). Although water has been seen as

the driver of civilisation, in other circles, scholars have argued for the reverse where civilisation is regarded as the mainspring of water engineering and science (see Jones 2004). Be that as it may, the emphasis here is on water as a critical component in the running of these civilisations.

Water is a very critical resource in the rise and development of cities to the extent that one of the theories proposed for the rise of cities has come to be regarded as the 'hydraulic theory'. The 'hydraulic theory' posits that state societies developed from large irrigation projects which required centralised coordination (Wittfogel 1956). The theory has its flaws, with scholars arguing that water management systems such as irrigation were actually a product, and not a cause for the development of these ancient cities (Adams 1960). In spite of such arguments, water still holds a central place with regard to ancient cities. According to Butzer (1976), most of these ancient cities are identified with hydraulic systems. This position is strategically rooted in the fact that most of the communities who built these cities were agro-pastoralists and consequently relied heavily on the availability of water. Some scholars argue that it might not necessarily be water in the form of large irrigation schemes but rain water and underground water that played a pivotal role in these early cities.

The centrality of water is also seen in the location of MachuPicchu in Latin America. Wright (2006) argues that the Inca engineers would not have built the royal estate of MachuPicchu if they had not found and developed a water source in the form of a spring which is found on the slope of the mountain. The centrality of water has also been established in the case of the ancient city of Jerusalem, whose water was supplied by a spring known as 'Virgin's Fountain' by Christians, 'Mother of the Steps' by Moslems and 'Aaron's bath' by the Jews (Masterman 1902). Water from the sacred spring played a pivotal role such that almost all the villages were built close to it. Various water management systems were put in place to ensure sustainable use of water. According to Rogers (2013), it was not by coincidence that London during Roman times was located close to the Thames River and highlights that a number of rivers formed significant features of the urban topography on either side of the Thames River. However, Rogers (2013) acknowledges that the London waterscape has changed over time.

In the Mediterranean, the history of interactions of ancient cities and water has been well documented (Barton et al. 2010). For the Middle East, Oates et al. (2006) argue that the rivers Tigris and Euphrates offered conditions conducive for the emergence of the ancient city states. According to Oates et al. (2006), activities on the land become dependent on the amount of water passing through that space. However, human activities could also affect the amount of water passing through. In this regard, various activities affect waterscapes differently and produce patterns which can be studied in archaeology.

From pre-colonial times to the present, the availability of water sources has continued to play a significant role in human settlement and spatial behaviour. The adequacy of water is of paramount importance to the sustenance of human life. The scarcity or abundance (cyclones, flooding, and typhoons) of water can be detrimental to societies. To this effect, several conferences and symposia have been organised to address water concerns.[1] A number of strategies which basically centre on the need to balance human need and the needs of the natural world have been put in place so as to sustainably manage the resource. Despite the critical role of water in sustaining human societies, ethno-historical accounts rarely make water a subject. Water only becomes a subject when rivers are used as boundaries between various levels of complexity such as chiefdoms and towns (Moore 2005; Shoko 2007).

Rogers (2013) argues that despite being downplayed, water plays a critical role particularly in shaping urban spaces and can greatly aid in understanding how such spaces were experienced and even how these landscapes have changed over time. However, Rogers (2013) argues that discussions on urban waterscapes, particularly in Europe is very much limited to piped water. When efforts are directed towards piped water, equally important forms of water such as rivers, rain and groundwater are not emphasised. These water contexts have been found to be very useful in informing the development and other uses of the land. It is against this background that Rogers (2013) suggests that water contexts or sources could be studied like any other archaeological artefacts. Hence, when undertaking spatial analysis, it is of paramount importance that all components of a site including waterscapes are incorporated. Socialising a landscape involves learning the landscape, and assessing resource distribution and accessibility. People then build relationships with sites by assigning meaning to them and ultimately setting the rules that regulate accessibility (Langley 2013). The socialisation of landscape is one of the unique attributes of human beings. Water, as a vital resource, thus cannot be separated from the socialised landscape.

As has been asserted by Harrower (2010), archaeologists have long noted the centrality of water, both in terms of access to and management of the resource, among ancient societies starting from forager communities to agriculturalists and state societies. Advances in GIS technologies have greatly aided in the analysis of the role of water which traditionally relied on aerial photographs and topographic maps. Harrower argues that GIS allows a far wider breath of analysis poised to generate significant new understanding of the ancient use of water resources

[1] Wessex Institute, UK International Water Conference, Water and Society 1st International Conference, 2011, Las Vegas; 2nd- 4-6 September 2013, New Forest, UK, 3rd- 15-17 July 2015, Coruna Spain; UN-Water Annual International Zaragoza Conference, Water and Sustainable development. From vision to action, 15-17 January 2015, Zaragoza, Spain, International Water Technology Conference organised by International Water Technology Association, Regional Conference[s] of the Southern African Young Water Professionals.

(Harrower 2010: 1447). Using such approaches is seen as an avenue of getting to know how the ancient people conceptualised and manipulated their environment. Other sites with similar statures as Great Zimbabwe such as MachuPicchu, Aksum and the Pyramids of Egypt have attracted scientific analyses of hydrology and water engineering (see Trampier 2009; Duxbury et al. 2015). It is therefore imperative to view Great Zimbabwe as a lived city with everyday water needs The study therefore draws insights from similar studies conducted elsewhere.

### *2.3.1 Water Management*

There are a number of strategies that have been employed to make the best out of the available water sources as well to increase the water available particularly for agriculture Water management is defined by Scarborough (1998) as the human interruption of the natural water cycle undertaken by a society. Thus water management involves the natural movement of water, redirection and collection of water as well as the social organisation, displayed. Egerer (2017) argues that the social organisation with respect to water management refers 'to the way in which water is shared, provided, and used among individuals or groups where .. often societies develop(ed) special governance structures to regulate water as a resource'. According to Egerer (2017), water features such as dams, reservoirs, canals, and wells are landscape alterations reflect on a groups land use practices and in-turn offers a window through which economic behaviour can be studied. Mithen (2010) argues that it was actually the domestication of water that enabled the consolidation and spread of farming lifestyles which in turn led to growth in population and the ultimate growth of urban centres Ghanbarpour et al (2007) points the four components of water management as 'management of rain, a system of conveying water for storage, storage tank or reservoir and a distribution system to deliver water to the point of use'. Stile (1996) compares water to energy resources in that water, as with energy, is commonly transmitted from its point of collection (generation) to its point of use, and it is in the transmission process that substantial losses (inefficiencies) are typically incurred Thus there is need for considerable amount of care needed in water management

The distortion of water from its original state, entails water management. Mithen (2010) notes that from few drops carried within a cupped leaf by Homo Habilis to modern engineering, shows that the water has been constrained and manipulated to cater for human needs for years. This suggests that Africa has not to be exempted when it comes to managing the water resource.

#### *A History of Water Management in Africa*

Africans have a long history of water management The evidence of water management systems in Africa is not only available, they also point to a sophisticated system (Mithen 2010) Ghanbarpour et al. (2007) notes that water management systems have been in place through centuries in arid and semi- arid regions like Africa where rainfall is not enough to meet the water requirements of most crop plants This is particularly true to populations who are known to have relied on crop production and animal husbandry. Thus, efforts to manage water have been especially made by agricultural societies. The need for water management has been necessitated by erratic rainfall and frequent droughts that the continent is faced with. The earliest manifestation of water management in the continent is found in Egypt along the Nile River. According to Mirti et al. (1999), remnants of ancient water structures, developed and used in Egypt and Mesopotamia dates back to 5000 B. C. He noted that in Egypt, the well dated irrigation project was built about 3100 B.C such that by 2100 B.C. several indigenous systems for irrigation were in use (Mirti et al. 1999). As noted by Mirti et al (1999), with time, the developed water management structures in Egypt and the Mediterranean were refined and were gradually adopted by the surrounding regions One such traditional water management method is the Shaduf, which has been well documented (Ghanbarpour et al. 2007). The earliest of the Shaduf method has been dated back to 1250 B.C along the River Nile from a tomb painting (Mirti et al. 1999)

For Aksum, an ancient city in the Horn of Africa, Sulas et al. (2009) argue that crops and animals were either rain-fed or relied on underground water. At Aksum, there were some water management systems which were put in place so as to sustain the ancient city This suggests that water, in its various forms, was central to the survival of these cities According to Olokesusi (2006), the history of mankind is to a large extent dominated by the struggle for and use of water because it is the most fundamental and indispensable of natural resources. The management systems continued to be shaped by the different climatic conditions and Olokesusi (2006), argues that this was sustained by a deep traditional knowledge of science and technology found in various facets of African societies prior to colonisation. Roudi-Fahimi et al. (2001) emphasises that strategies to deal with water scarcity is depended on local conditions.

In South Africa, reference is made to the rock tanks on the hills of the Shashe—Limpopo Confluence which is argued to have been central in the rain-control rituals at sites such as Mapungubwe (Schoeman 2009) Widgren et al. (2016) also analysed the terraces in Mpumalanga province and concluded that these were meant to control soil erosion and rapid rainwater by the Bokoni cultivators. Rainfall plays a central role despite the various water management strategies. Ward (2016) observes that even though communities in Africa have made strides in managing water particularly for irrigation, rainfed agriculture will continue to dominate for the foreseeable future.

With regard to Zimbabwean archaeology, it seems water only becomes a key issue when archaeologists analyse riverine settlements and the Nyanga terraces (see Pwiti 1996a, 1996b; Soper 2002, 2006; Katsamudanga 2007). Pwiti (1996a) argues that the settlement patterns exhibited

by Early Farming Communities (EFC) in the Zambezi valley follow or are regulated by riverine environments or contexts. The trend is attributed to the necessity of domestic water as well as water for agricultural purposes since the economy of these EFC relied heavily on agriculture It is also important to note that the presence of water makes the soils conducive for agriculture Katsamudanga (2007) examined the hunter-gatherer rock art sites in the Eastern Highlands of the country, and concluded that the distribution is a function of the availability of water Thus from a Zimbabwean archaeology perspective, studies have focussed on how water availability has influenced the distribution of sites.

## 2.4 Water at Great Zimbabwe

There has been very little scholarly research on water use at Great Zimbabwe. The few instances where water is mentioned at Great Zimbabwe is when there is a discussion on the Chisikana spring, the sacred spring at the site, as well as reference to rainmaking ceremonies. In some early publications (Bent 1895; Hall 1905a; Hall and Neal 1904), there is also the mention of Shagashi River which is a few kilometeres north of the site The mention of water is also seen when scholars refer to the Watergate path (Ndoro 2005; Fontein 2006a, 2006b). From earlier works, it is clear that the Chisikana spring used to provide good drinking water to the site. Hall (1905a) referred to the Chisikana spring as the Zimbabwe spring He described the spring as the source of good drinking water. 'Fifty yards behind the Ridge Ruins is the Zimbabwe Spring, marked by a group of trees, where most excellent water can be obtained, even during the driest season' (Hall 1905a: 8)

Fontein (2006a) highlights the conflicts between the Nemanwa and the Mugabe clans over control of the Chisikana spring. From accounts collected by Fontein (2006b: 23), Chisikana spring plays a central role in the oral traditions of the Nemanwa clan who trace their origin to a little girl (*Chisikana*) who, according to the legend, was taken by mermaids and later resurfaced at the spring. This is the reason why the spring was named *Chisikana* The Nemanwa clan claim that they 'germinated' (*vakamera*) at Great Zmbabwe This history which relates a clan to the spring is not only perculiar to the Nemanwa clan, but the Mugabe clan also have a similar narrative hence, Fontein (2006b) argues that the story might have been created as part of re-negotiation of the past process.

Some scholars also make reference to the Shagashe River which was dammed at its confluence with Mutirikwi River to create Lake Kyle (now Mutirikwi). Indication by early researchers is that though not very prominent, the Shagashe River may have been one of the sources of water for the people living at Great Zimbabwe. Bent states that a few hundred yards from Great Zimbabwe was Shagashe River 'within easy reach of Zimbabwe' and flowing into the Tokwe River (Bent 1895: 53). Bent (1895) also points to the swampy nature of the area surrounding Great Zimbabwe. He highlights the fact that there are a number of streams and rivers around Great Zimbabwe.

The first mention of the Watergate path to refer to the route leading into the Hill Complex from the western side appears in early 20th century texts on Great Zimbabwe. Early writers highlighted that the path was so named due to its close proximity to a large water-hole which is one of the water-holes around the hill from the south west to the north east (Hall 1905: 8). Hall (1905a) highlighted the artificial nature of these water-holes during his exploratory work at Great Zimbabwe. However, no further investigations were ever done. This book, thus goes beyond the analysis of built structures at Great Zimbabwe to include the relationship between water and the built environment. The study, therefore, falls within the broader framework of landscape archaeology

One of the theories that has been put forward on the function of the Great Zimbabwe was that the walls were built for security reasons. Citing the 'impregnable' walls on the Hill Complex, some scholars have argued that these stone strcutures were built for purposes of defense (Mennell 1903: 8). Mallows (1986) is skeptical of the idea that the Hill Complex may have been built for defensive purposes because of the absence of water sources needed in times of siege This theory has not been received by many scholars. Against this background, this study seeks to establish sources of water at Great Zimbabwe. In addition, the study provides insights on the water management systems at the site

One of the key questions that have intrigued researchers on Great Zimbabwe is whether there was any form of water engineering either in the form of irrigation or building of canals On water engineering, there is the mention of the drain holes within the drystone walls. Masey (1911) makes mention of the drain holes as well as steps that characterise doorways as water management strategies that were put in place at Great Zimbabwe. The drain holes were meant to keep the inside of the enclosures habitable by keeping them free from flooding. Besides the drain holes and the steps, the inside of the enclosures was paved with granite so as to avoid water accumulation Huffman (1972) argues that it is not possible that any irrigation activity took place at Great Zimbabwe. The current study seeks to address the question of water engeneering through an examination of water and water related features and processes at the site. Through hydrological modelling, the role played by water in the rise and fall of Great Zimbabwe is also examined Utilising techniques in spatial analysis, the study analyses the interface between water and the built environment at Great Zimbabwe, in particular, models of how the people could have traversed their landscape to obtain water are examined.

## 2.5 Conclusion

The chapter has highghted the nature of archaeological research that Great Zimbabwe has received since the end

of the 19th century. This has shown that despite many years of research at Great Zimbabwe, there still exists a lacuna in our knowledge of the salience of water in the everyday lives of the people who lived in the city or regularly visited it. This is despite the attention that water has been given globally, particularly in the development of ancient civilisations Research done at other ancient cities has shown that the availability of reliable sources of water informed decisions on settlement choices In some instances, there was a strong interface between water sources and the exploitation of this resource and the built environment. Thus, besides understanding the importance of water at Great Zimbabwe, the study also looks at spatial organisation and how it is entangled with exploitation of resources such as water A multidisciplinary approach is therefore needed in order to obtain a better understanding of the Great Zimbabwe site

# 3

# Theory and Methods

## 3.1 Introduction

This chapter presents and evaluates the various research methods that have been used in this study to examine the history of water and water management at Great Zimbabwe during its occupation. The chapter proceeds to provide the justification for the methodological and theoretical approaches that are used in the study. The research is aimed at establishing the relationship between water as a resource and the settlement history of the site. This involves understanding how water was transported or transferred from source areas to habitation sites. Further, the study investigates how the water resource sustained the population that occupied Great Zimbabwe. To achieve these goals, the study makes use of a number of data gathering methods which include archival research, ethnographic research and archaeological surveys. GIS is used as an analytical tool to model hydrological processes such as surface run-off and wetness at the site as well as other processes such as the ferrying of water from source to residential areas. The chapter discusses the efficacy of different methodological approaches as well as their limitations and challenges. The first part analyses the broad theoretical frameworks that have been used in understanding the use of space at Great Zimbabwe and other ancient cities. It is crucial at this point to note that theories analysed in this chapter deal with spatial organisation and the relationship between resources such as water and space. The chapter makes a case for the use of non-intrusive methods such as GIS and hydrological modelling to analyse the use of space at Great Zimbabwe, especially in understanding the centrality of water on spatial configurations as well as everyday life in the city. The second part of the chapter examines the methods used in understanding water as a resource at Great Zimbabwe.

## 3.2 Landscape Archaeology: An Overview

Archaeologists have since taken interest in space in their analysis of archaeological phenomena (Knapp and Ashmore 1999). Wheatley and Gillings (2002) argue that the basis for the interest in space is that most if not all archaeological evidence is found 'somewhere' hence there is a spatial component. This research is a product of the necessity for interdisciplinary approaches to archaeology, where it has been noted that various disciplines can be incorporated in the quest for archaeological data without compromising the results. It is against this background that the study is premised on the methodological and theoretical framework of landscape archaeology. The concept of landscape archaeology is summarised by Van Leusen (2002) who states that the basis for the approach is that past human action may leave an essentially continuous 'blanket' of traces anywhere on the physical landscape such that the resulting surface record is a palimpsest of such traces through time, and that patterns in this record may be explained in part by the in turn limiting and enabling qualities of the landscape (Van Leusen 2002: 12). For Fennell (2010), 'Landscape archaeology involves the use of archaeological, documentary, and oral history to study and interpret the ways past peoples shaped their landscapes through the deployment of cultural and social practices, and the ways, in turn, that such people were influenced, motivated, or constrained by their natural surroundings' (Fennell 2010: 1). In the process of understanding this relationship, various approaches have been used. The use of these approaches has enabled landscape archaeology to 'facilitate bridging the divide between processual and post processual archaeology' (Anschuetz et al. 2001: 159). Fennell (2010) highlights some of the various approaches utilised in landscape archaeology which include 'uses of satellite and aerial imagery, ground surface surveys, topographic modelling, stratigraphic excavations, geomorphology assessments, paleo-ethnobotany analysis, macrofloral and microfloral studies, and ground penetrating prospection technologies'. Such techniques have been utilised to study and interpret subjects as diverse as prehistoric roadways in Chaco Canyon, formal gardens of elite Anglo-American houses, spatial configurations of antebellum plantation structures and the domestic sites of enslaved labourers, and the field systems of Mesoamerican civilizations (Fennell 2010). It is the human input that defines a landscape and this is emphasised by Anschuetez et al. (2001), who argue that the term landscape is not a synonym for the natural environment, but instead that landscapes are rather products of cultural activities where human beings, through their daily activities, beliefs, and values, transform physical spaces into meaningful places. Zubrow (2005) highlights how spatial analysis has developed in archaeology with the earliest stages characterised by interests in the number or type of features or content at a particular location, thereafter becoming more ambitious and seeking to understand both whole spatial systems and human spatial cognition. This study deploys spatial analysis to characterise locational patterns of individual sites and interactions between sites as well as spatial simulation of processes such as surface water flow and human movement. Various approaches have been borrowed from other disciplines particularly from geography with others developed purely in archaeology to address landscape issues.

### 3.3 Development of GIS Use in Archaeology

The use of GIS in archaeology can be traced from the 1970s, where initially it was used as a data management tool (Wheatley and Gillings 2002). It then developed from being used for data management to a tool that could also be used for the analysis of data in the 1980s in the United States of America and Europe. In these areas, GIS gained currency especially in Cultural Resources Management (CRM). From the 1990s, GIS analytical tools began to be utilised in archaeology. Since then, GIS applications have increased. The continued use of GIS in archaeology is as a result of the concept of 'digital world'. In the 'digital world', Information Technologies (IT) is being used in almost every aspect of human life. According to Daly and Evans (2006), almost every discipline is in the process of understanding how to productively apply computers in their day to day activities. As a result, 'computers have actually moved from almost inaccessible to an everyday device that we rely on' (Daly and Evans 2006: 2). It is within this context that the major digital applications in archaeology have been in the area of GIS. Wheatley and Gillings (2002) argue that contrary to popular mythology, contemporary archaeologists may spend more time using GIS than a trowel.

Debates surrounding the application of GIS in archaeology cannot be separated from the theoretical developments in archaeology in general. This quantitative approach has seen much of its criticisms from post-processualists who argue that the human cognitive aspects are removed if quantitative methods are used (Tilley 1994). The processualist has since been integrated with the post-processual approach. With reference to archaeological landscape studies, the trend has been to go beyond quantification of the physical environment that shapes human behaviour. Studies have incorporated cultural and symbolic aspects of the past societies (Manyanga 2006). Some have overemphasised the incompatibility of particularly post-processual archaeology and digital methods, arguing that while the former is interpretive, narrative and deconstructive, the latter is analytic, measured and reconstructive.

GIS has also been viewed as environmentally deterministic. Gaffney and Van Leusen (1995: 367) define environmental determinism as a 'theoretical approach that regards past cultures as somehow functions or shaped by environmental pressures.' According to Erickson (1999: 634), in extreme cases of environmental determinism, 'humans are considered pawns at the mercy of droughts and floods'. The argument is that if a study is environmentally deterministic, it leads to the neglect of ritual and cognitve aspects of site location. Gaffney and Van Leusen (1995) emphasised the need to incoporate belief systems and perceptions in archaeological investigations. The basis for this need is the realisation that the physcal environment is also shaped by culture and belief systems. In advocating for an alternative approach, post-processualists, led by scholars like Julian Thomas and Christopher Tilley (see Tilley 1991), have emphasised the need to consider the influence of social and cultural factors and also relativist perspectives. However, such an approach has been viewed as a simple replacement of environmental determinism with social determinism (Kealhoffer 1996)

A more recent approach emphasises the need to take into account of both the social and environmental concepts Wise (2000) observes the interrelatedness of culture and environment and advocates for consideration of changes occurring through space and time in both society and environment as necessary components in any study Gaffney and van Leusen (1995) argue that as long as the cognitive aspects of societies produce spatial patterns, these qualities become measurable. Kealhoffer (1996) emphasises the absence of 'ultimate casualty' or linear patterns of adaptive change. The relations between different cultural groups with different belief systems and the environment is rather characterised by disjunctures and discrepancies Kealhoffer (1996) therefore advocates for a theoretical orientation that can draw concepts from the two extreme positions of environmental and social determinism. Gaffney and Van Leusen (1995) highlight two scenarios that lead to environmental determinism when using GIS in archaeological analysis. These scenarios involve the use of limited data as well as limitations on the functionlity of GIS. Limited data is linked to the daunting task of producing the data that can be put in a GIS program. As a result, most researchers end up using available data

With regard to water, Mosse (2008) emphasises the need to view water harvesting, distribution and water use as an ecological-institutional whole which integrates the technical, political as well as cultural spheres. In the Middle East, a GIS contribution in understanding archaeological phenomena has been documented (see Hritz 2014) Bevan and Connolly (2004) demonstrated the power of GIS in identification of spatial patterning as well as understanding the processes influencing artefact distribution in the island of Kythera, Greece The study is primarily conceived with the general theoretical frameworks used in contemporary spatial studies in mind (Djindjian 1998; McCoy and Ladeforged 2009). Zubrow (2005) highlights how spatial analysis has developed in archaeology from the earliest stages characterised by interests in the number or content at a location to spatial systems, then to spatial cognition.

#### *3.3.1 GIS Applications in Zimbabwean Archaeology*

GIS applications in Zimbabwean archaeology have been well documented (Katsamudanga 2007; Musindo 2010; Katsamudanga and Musindo 2013). The major highlight is how GIS has moved from cartographic towards more analytical functions. Utilising the cartographic function of GIS involves the production of 'aesthetic' maps. This differs from the analytical function, which focuses on the quantification as well as qualification of the spatially distributed phenomena.

In most African countries, up until recently, GIS has not been used in archaeological research. The absence of such

approaches has been the bane of archaeology, especially where techniques are borrowed from other disciplines Arguably, the time spent in learning the technicalities is at the cost of 'real' archaeology. This might explain the slow adoption and adaptation of GIS in African archaeology. In Zimbabwean archaeology, interest in spatial studies has been demonstrated in a number of works (Pwiti 1996a, 1996b, 1997). Wheatley and Gillings (2002) emphasise the point that the majority of 20th century spatial archaeological data has been tabulated and plotted by hand on simple flat maps. This has been referred to as the conventional/traditional method. The works of Soper (1996a, 2002) are an example of spatial studies being done based on the concept of thematic mapping with some of the transparent maps used in the studies being attached at the end of the books. At Great Zimbabwe, a number of researchers have since seen the potential of GIS in providing new insights on the site (see Ndoro 2001). Sinclair (1987, 2010) used GIS tools to map the different features around Great Zimbabwe.

After being equipped with the necessary skills required to undertake GIS research, the other obstacle that researchers working in Africa face is the unavailability of paleo-environmental data. The challenge has been seen as affecting many GIS based archaeological analyses even outside the continent. Exon et al. (2000: 20), allude to the problem in the case of the Stonehenge, England, pointing out that lack of adequate paleoenvironmental data is a problem in GIS analysis in archaeology. As postulated by Warren and Asch (2000: 5), besides the assumption of environmental choices having influenced choice of locations, there is also the assumption that the portrayed environmental factors are represented by modern data Hence, most of GIS modelling use modern environmental data as proxy for situations that obtained in the past Direct inferrence is considered problematic and can be misleading (Duncan and Berkman 2000: 55)

GIS in general and hydrology models in particular have also received criticism due to their use of the modern environment as a proxy for past environments Modern environmental and climatic conditions might be very different from the ones in the past. Dore and Wandsnider (2006) question the representativeness of the environmental data during the time these landsapes were utilised. The assumption is that the height above sea level and the geology remained unchanged over the years. There is always a problem in using modern data to interpret archaeological findings. Musindo (2010) illustrates the dangers of using recent data to interpret archaeological phenomenon by using Chirawu's work in Nyanga. Chirawu (1999) observes that modern land classification in Nyanga is divided into seven classes. The most agriculturally productive land is class 1, but 'heavy terracing is actually found in land class six and seven which is suitable only for rough grazing or sometimes afforestation' (Chirawu 1999: 3). This therefore can be explained by environment change overtime, and therefore points to the need for caution when undertaking similar studies

While acknowledging that past environmental conditions in most areas are different from the present ones, Kvamme (2006) argues that elements such as terrain are fairly stable. Paleo-environmental reconstructions are overwhelming and as a result they are rarely done. They require a considerable amount of work and time. Besides the daunting task of paleoenvironmental reconstructions, the outcome usually comprises generalisations with little in terms of specificity (Kvamme 2006: 16). Thus most research projects continue to use present day environmental data

### 3.4 Methods: Data Acquisition

The data acquisition process produced a wide spectrum of information, ranging from topographic, physiographic, geological, floral and ethnographic data. The data was digitised for subsequent data analysis in GIS, an Information Tool (IT) which makes it possible to integrate and analyse spatial data. The first phase of the research was a desktop survey which included the consultation of the National Museums and Monuments of Zimbabwe (NMMZ) database on sites recorded within the Great Zimbabwe site territory. The research acknowledges earlier work that has been done with regard to establishing the location of sites and features within the Great Zimbabwe area. From the desktop survey, data on site locations and various projects that have been done on the ancient city of Great Zimbabwe were obtained. The main objective was to locate water sources and relate these to water use and management at the site. Part of the desktop survey therefore included a survey of secondary literature which provided information on the paleoclimate of southern Africa (Tyson and Lindesay 1992; Holmgren and Oberg 2006). Three data collecting techniques were employed: archival research, ethnographic enquiry and archaeological surveys. The results of any GIS analysis depend on the quality of the data hence much effort was put on data gathering

#### *3.4.1 Archival Research*

Archival research was mainly useful in obtaining data relating to the environmental history of the site as well as the management of the site since the 1890s. Primary documents in the form of memoranda, letters, diaries and reports were examined. The National Archives of Zimbabwe was the key source of data In particular, the Ministry of Internal Affairs Files relating to Great Zimbabwe Monument as well as General Administrative Correspondences such as letters from the early curators of Great Zimbabwe to different government departments were consulted. These include letters meant to inform responsible authorities of the developments around the monuments which altered the vista of the site, such as the establishment of a golf course to the west of the Hill Complex. Analysis, therefore, focused on those records

relating to the landscape of Great Zimbabwe prior to the developments that later on took place such as the construction of the hotel and the establishment of a golf course, which altered the vista of the site.

More archival work was conducted at the Great Zimbabwe National Monument, where various records dating to as early as 1900s are available. The Great Zimbabwe archive has materials which are not available at the National Archives. Examples of such include a collection of aerial photographs as well as diaries of previous curators of the site. The limitation of using such archival data was that in most cases, the officials had very little knowledge of the landscape to appreciate all the water sources around Great Zimbabwe. It is also possible that there were more water sources than those which the curators of Great Zimbabwe were able to identify and document. More ethnographic research can potentially reveal more water sources such as sacred springs and pools. Drewett (2011: 49) emphasised the need for caution in considering data from early Europeans who visited the site noting that 'the fact that surviving fifteenth century documents for a region make no mention of settlements in a particular area does not necessarily mean there were none'. With this limitation in mind, archival files were used in conjunction with archival photographs and aerial photographs of the site which were obtained from the National Archives of Zimbabwe, the Zimbabwe Surveyor General's Office as well as ethnographic data. These aerial photographs provided invaluable data on the landscape around the site. Aerial photographs have proved to be an important resource in understanding landscape histories (Bierman 2005; Morgan et al. 2010; Cowley et al. 2010; Hashim 2010). The major limitation of using aerial photographs as a research tool in the context of Zimbabwe is the fact that these photographs are incomplete (Whitlow 1988). In most cases, there are gaps in the collections of aerial photographs. Given this background, the archives together with the aerial photographs were used to complement each other. Aerial photographs were analysed using GIS with the objective of establishing how the landscape has been changing over time. Apart from the historical photographs obtained from the National Archives of Zimbabwe and the Conservation Centre at Great Zimbabwe, the study also made use of contemporary photographs taken during fieldwork. In addition to being used as illustrations, these photographs are sources of data with potential of revealing various processes in water use and management as well as being a record of the changes that have occurred at Great Zimbabwe since the first Western observers reported it to the outside world.

Apart from archival material, secondary data was consulted in the study and these offered in-depth information on the paleoclimate of the region. Much of the information gleaned from such documents relate to the past climatic conditions which are regional, covering Southern Africa and not necessarily specific to the site of Great Zimbabwe (see e.g. Tyson and Lindesay 1992; Holmgren and Oberg 2006). An example of paleoclimate reconstruction from secondary sources is Huffman (2010b) who argues for a correlation between burnt structures and severe drought (during El Nino events) in the Iron Age of southern Africa. The burning is taken as a socio political response to the environment hence gathering such information is critical to gain insights on the past climate. The research also involved the acquisition of rainfall data from the Zimbabwe Meteorological Department and numerous maps from archival files. These were necessary for the construction of rainfall history at the site. In hydrological modelling, rainfall data is a critical component and a 'key variable regardless of the climate region' (Andersen 2008:45). Data on land use, vegetation, topography, soils and geology was obtained from the relief maps kept at the National Museums of Monuments of Zimbabwe (NMMZ).

### *3.4.2 Ethnographic Enquiry*

Ethnographic enquiries were undertaken at two levels. They were used as a method of establishing the landscape modification history of the site and as way of interpreting archaeological phenomena at Great Zimbabwe. Ethnographic enquiry is a vital tool in obtaining data on traditional water management methods (Scarborough 1998; Scarborough et al. 2000; Lane 2009; Orlove and Caton 2010). Sutton (2017: 10) emphasises the possibility of 'probing backwards' from the present. He argues for a correlation of archaeology and anthropological insights, especially ethnographic studies and linguistics, as well as oral testimonies and written accounts, wherever available. Using published literature, aerial photographs and local community knowledge, an investigation was done to determine patterns of changing land use around Great Zimbabwe. The landscape history is traced from the period when Great Zimbabwe was publicised to the outside world by early explorers (Bent 1892, 1893a; Hall 1905a, 1905b; Hall and Neal 1904). The ethnographic enquiry took the form of informal interactions with people still living around Great Zimbabwe as well as traditional authorities such as chiefs. As someone familiar with communities around Great Zimbabwe, having worked as a resident archaeologist at the site, the interactions remained largely informal. The information gathered relates to known and potential water resources around Great Zimbabwe. In particular, oral interviews were conducted for purposes of recording the water history of the site as well as the land-use history of the site. The key informants were the people who live around the site and have interacted with it for a long period of time. By using informal interactions together with oral interviews, the study is in tandem with 'standard' ethnographic methods where emphasis is put on the need to integrate multiple data sources and methods of data collection to increase the validity and trustworthiness of the findings (e.g. Hammersley and Aitkinson 2007). The first level of the ethnographic enquiry was meant to establish the landscape history of the site. This was through documentation of how water was obtained and managed. The ultimate goal was to gain an insight into the landscape which obtained prior to the modifications that took place at the site from around 1900. The interviews

yielded information about the landscape changes at Great Zimbabwe, water sources and the various traditional methods of water management

Apart from ethnographic enquiry, another key method employed in the study is ethnoarchaeology. Stiles (1977) define ethnoarchaeology as encompassing all the theoretical and methodological aspects of comparing ethnographic and archaeological data including the use of ethnographic analogy and archaeological ethnography The ethnoarchaeological approach takes the form of the direct historical approach which according to Slotkin (1952) is fruitful when applied to recently extinct cultural systems The use of ethnoarchaeological approaches is in line with Stanislawski (1980)'s argument that archaeology, like any other scientific explanation, moves from the known to the unknown. An ethnoarchaeological approach differs from 'normal ethnographies' in that whilst the later focus on social, economic, and linguistic aspects of a society, the former emphasises the physical manifestations of activities (Stiles, 1977: 89). Deal (2017) argues that even though it is a commonly held belief that ethnoarchaeological models are most valuable when they can be linked through historical documentation to past cultures in the same region, there is need to consider cultural change in the context of outside influence. Lyman and O'Brien (2001) argue that physical manifestations are also visible in the landscape, leaving marks and scars. It is in this regard that the ethnohistorical approach was deployed so as to get the relationship between human behaviour and the physical environment for the purposes of inferring meaning of physical features and the 'scars' on the landscape.

### *3.4.3 Archaeological Survey*

Archaeological surveys were undertaken as one of the data acquisition methods. The archaeological surveys were used to complement data from earlier surveys that have been conducted around the site by Ndoro (2001, 2005). The surveys took a 'ground truthing' form as a result of the availability of maps and secondary sources as well as satellite imagery on the Great Zimbabwe area The surveys were meant to verify and understand the geological and environmental characteristics of the region as well as the micro environments that also form part of the landscape. Understanding the geology and environment of the region helps in building relationships between water resources and the archaeological features and structures of the site. The use of archaeological surveys in the study is an acknowledgement that the surface retains sufficient patterns to predict subsurface deposits (Dunnell and Dancey 1983).

One of the important steps in carrying out field research is to define the geographical area of study. Redman (1987) identifies three basic stages of a field project, which are, the definition of the region or site under investigation in terms of boundaries, refinement of the knowledge about settlement structure, and distributional analysis; these are usually guided by specific problem formulations

The initial phase of the archaeological surveys aimed at understanding the relationship between Great Zimbabwe and its water resources involved demarcating boundaries of the study area. The setting of boundaries in archaeological surveys is unavoidable. Dunnell and Dancey (1983: 271) argue that anyone who has done much fieldwork is aware that distinguishing a site and setting its boundaries is an archaeological decision, not an observation An arbitrary boundary of a radius of 10km was used to define the area to be investigated. The use of an arbitrary boundary is a concept that has a history of application in archaeology (see Roper 1979). This is based on concepts borrowed from economic geography particularly the concept that humans minimise effort, maximise returns or in some way make optimal decisions in their interactions with the physical environment (Kantner 2005). Though the focus for the research area is a radius of 10km from Great Zimbabwe, the real area of study was defined by the catchments produced through the data analysis. The archaeological surveys therefore took a 'siteless' approach, an approach which undermines obtrusive features (sites).

The common approach used in archaeological studies is to define and identify sites and then use them as the basis for subsequent analysis (Dunnell 1992). The site usually becomes a focal point for further analysis. It is this notion of a site that Dunnell and Dancey (1983) argue against when they point out that it is ill-suited to regional-scale data collection and obscures much of the information that a regional perspective uniquely offers. Kvamme (2006: 5) argues that human behaviour is continuous Discrete boundaries are not present in human behaviour, making the concept of a site meaningless. Dunnell (1992: 228) argues that 'common sense origin of site led to its early fixation in practice and law before we were equipped to appreciate the intellectual baggage or could anticipate the myriad of practical problems it entails'. Against this background, this study adopted a siteless approach so as to understand the landscape in its totality.

Terms such as 'anti-site', 'distributional archaeology' as well as 'background noise' have been used to refer to the approach that disregards the concept of site According to Banning (2002), the history of the siteless approach is traced to the 1980s Proponents of a siteless approach argue that by defining a site when undertaking archaeological surveys, artefacts and features outside 'the site' are left out. Dunnell (1992) argues that sites are 'ambiguously defined, multifaceted entities that are stipulated rather than constructed from more basic elements'. According to Banning (2002), the definition of a site is limited to concentrations of material culture. Purtill (2012) argues that theoretically, siteless archaeology is based on the premise that artefacts and their spatial distributions should be basic units of analysis rather than the site Purtill (2012) also argues that archaeological sites are arbitrarily defined and as such, their formulation may not accurately reflect past human behaviour and may even mask it The idea of adopting a siteless approach is informed by the realisation that most individual artefacts are meaningless outside

these associations (Kantner 2005: 1188). Banning (2002) asserts that the basis for a siteless approach is that the landscape is not comprised of sites and empty spaces but rather several hosts of activities. Therefore, the idea of a spatial break is done away with using a siteless approach. Several landscape archaeologists have resorted to the methodology with archaeological surveys having been done with minimal definition of a site (Banning 2002). Against this background, a siteless approach was adopted for the study.

As part of the archaeological survey, the study documented both archaeological resources, and geological and pedological processes. The target was features in the landscape which show evidence of processes such as geomorphology and biodiversity. Purtill (2012) argues that landscape archaeology includes examination of natural geomorphic processes and their impact on cultural settlement patterns as well as how such processes affect the archaeological record. The method of documenting all these entails large amounts of data which, fortunately, can easily be handled in a GIS program. A siteless approach offers an opportunity for equal coverage of areas that are considered both 'rich' and 'poor' in artefacts. As pointed out by Purtill (2012: 13), the approach 'provide[s] a more comprehensive view of the environment utilization strategies and provides clues as to why certain areas are preferred for specific activities while others are avoided'. According to Banning (2002), the siteless approach is used in understanding relationships of settlements relative to one another as well as the environment.

The 'siteless' approach adopted for the study has, however, its own flaws. One challenge of a siteless approach is related to the handling of large amounts of data. The arguments against the siteless approach mainly stem from the difficulty encountered in dating surface finds (Dunnell, 1992: 34). This has been dismissed on the basis that all buried deposits were once surface deposits. 'The lack of broader impact of siteless view seems to lie in a failure to appreciate that the non-site view is not a different interpretation of the discipline subject matter but a different view of what the subject matter is' (Dunnell 1992: 38).

Even though siteless archaeology proves to be a valuable tool in regional survey, the notion of a site is indispensable. This is partly a result of administrative as well as Cultural Resources Management (CRM) perspectives. In CRM, the need to have a site is necessary for the purposes of specifying exactly what is to be protected. This is one of the reasons why Dunnell (1992) argued that 'the concept of the 'site' dominates archaeology and provides the basis for the administrative and interpretive framework for a broad spectrum of archaeological evidence'. Kantner (2005) highlights that in the absence of a site, it will be difficult for administrators to make management policies and decisions about recording a number of assumptions. In this regard, the site apparently has become the archaeological entity recognised by government agencies and other preservation laws. For this reason, the study's definition of a site includes any features which have a bearing on human use of the landscape. The definition of a site in this study included water-related features on the landscape. These include natural and man-made depressions, the large holes which have been seen to be a result of extraction of clay for the construction of earthen structures at the site (*dhaka* pits) and springs (running and extinct ones). To understand the utilisation of water, the survey also aimed at locating ancient water installations such as canals, open pools or water collecting features. Archaeological surveys were designed to document known water sources and potential water sources.

The features documented in the study included permanent water sources and features like water harvesting pools. The pools considered were either natural or man-made. The importance of the inclusion of natural pools has been highlighted by Barghouth and Al-Sa'ed (2009) in the case of water management in the ancient city of Jerusalem. They observed natural topographic ponds and those created by quarrying as critical in understanding water management in the city. Purtill (2012) argues that landscape archaeology includes the examination of natural geomorphic processes and their impacts on cultural settlement patterns as well as how such affect the modern day archaeological record, hence these are investigated as sites. Therefore, in this study, water sources and any geomorphic water-related features are treated as sites.

The detection of these features and artefacts in the area was achieved through the use of non-statistical methods. This is contrary to Banning (2002) who highlights that the common answer to the question of how archaeological sites are found is the use of a statistical sample. Considering the type of data required for the study, non-statistical methods were employed to gather the information. Statistical methods of finding archaeological sites are good at discovering 'common' archaeological phenomena (Banning 2002). Banning (2002) gives an example of surveys designed to discover highly clustered material culture like sites which cannot be expected to be effective for helping detect or understand ancient human activities that were dispersed on the landscape. The strategies and methods of implementing the survey are consistent with survey goals which aim to document these 'archaeologically rare' water sites.

The surveys were purposive, involving the use of available information such as knowledge on the occurrence of springs. The available information in the study included information on where springs, for example, are likely to be found. The deployment of a purposive strategy therefore meant the improvement of chances of discovering targets. Intensive field survey was conducted. As stated by Banning (2002), when undertaking a study of establishing patterns, it has to be intensive. Otherwise, omitting more than a few sites might hopelessly confuse the interpretation of a pattern. Intensive surveys were conducted within the 10km radius of the Great Zimbabwe site. Kantner

(2005) highlights that methods used in a siteless regional analysis include surface analyses that display spatial patterning of artefacts or other items of interest. The surveys also included the mapping of individual water features within the site. The surveys were done so as to locate sites, potential water resources and artefacts in space with the objective of understanding the periphery of Great Zimbabwe hence its size as an ancient urban city. The documentation process included GPS measuring and photographing. The surveys also involved mapping of the geomorphology of Great Zimbabwe to understand the drainage pattern, and the hydrological behaviour of the site territory or catchment. The mapping was also done so as to understand how surface runoff could be affected by the various physical features. The site surveys helped in systematically locating hydrological features such as waterways, wells and springs and how these related to the dwellings.

### *3.4.4 Digital Elevation Model*

A Digital Elevation Model (DEM) was acquired and used in the analysis. A DEM is defined by Burrough and Mcdonnell (1998) as the quantitative model of a part of the earth's surface in digital form. In its simplest form, a digital elevation model is a digital representation of the earth's surface (Porggio and Soille 2009) representing elevation, although not restricted to topography and landform (Wheatley and Gillings 2002). Whereas on paper maps the terrain is represented by contour lines, a DEM entails continuous data representation (raster) where the surface is represented in pixels. Each cell has a quantitative value that signifies the mean elevation across the defined area (Connolly and Lake 2006). The DEM usually forms the basis for most GIS analyses (Burrough and Mcdonnell 1998), and in partiular, hydrological modelling (Harrower 2010). Any process of modelling the earth's surface relies on Digital Elevation Models. Consequently, the prerequisite data for hydrological modelling in a GIS environment is a DEM. A DEM consists of grid cells with associated elevation values from which patterns of flow direction and flow accumulation can be modelled with GIS (Maidment 1996). A crucial component in the modelling of hydrological processes such as run-off, catchment delineation and determination of the nature of the surface-groundwater interactions is a DEM that accurately captures the terrain (Hoffman and Winde 2010). A DEM allows surface flow pathways to be identified without resorting to complicated hydrological modelling techniques (Jain and Singh 2005). An alternative to the production of the DEM for Great Zimbabwe was the digitisation of contour lines from topographic maps, which could be interpolated to produce a continuous surface (raster format). The process of interpolation entails the estimation of value properties at unsampled sites within the area covered by existing point observations (Wheatley and Gillings 2002). In this respect, if the contour lines have an interval of 20m, it would mean the DEM would have a resolution of 20m. Digital Elevation Models differ in quality depending on the method used to produce them (Wise 2007). This is, however, a traditional approach which is time consuming. An alternative to having a DEM in place is acquiring it from satellite imagery. The DEM for the Great Zimbabwe area was therefore acquired from satellite imagery after an evaluation of availability, accessibility, format, resolution and time.

There are a number of space agencies such as European Space Agency, Germany Aerospace Centre (DLR), Indian Space Research Organisation (IRSO), Japanese Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) or the National Aeronautics, Space Administration (NASA) and American US Geological Survey (USGS) Earth Explorer that offer satellite imagery for DEM extraction, both on a commercial and free of charge basis. The satellite imagery that is free of charge usually has poor resolution. In most cases, free DEMs have a resolution of around 90m which is too low for hydrological modelling. Hoffman and Winde (2010) recommend topographic contours of 20m interval (20m resolution) as acceptable for a DEM at regional scale. Nevertheless, it is insufficient to capture the required degree of detail in smaller areas.

NASA's Mission (SRTM) 1-arc second data was downloaded from the USGS website http: /earthexplorer.usgs.gov/. SRTM digital elevation data provides a major advance in the accessibility of high quality elevation data for most parts of the world free of charge. Thus, besides offering a worldwide coverage, SRTM Global elevation data offer worldwide coverage of void filled data at a resolution of 1 arc-second (30 meters). Despite the fact that it is free, it has high resolution data. The SRTM DEM was thus the most ideal tool because of its resolution of 30m. The need to have a correct DEM needs to be emphasised as results obtained depend on the quality of the DEM. There is also need for topography to be correctly represented in hydrological modelling. Forkuor and Maathuis (2012) did a comparative analysis of DEM derived from ASTER and SRTM and concluded that under 'bare earth' conditions, for example, SRTM provides accurate measurements. In an area covered by forests, the data from SRTM is likely to misrepresent the earth's surface. In a savanna environment like the one at Great Zimbabwe, SRTM provides a more accurate representation of the topography. For hydrological modelling, the need for an accurate DEM has been highlighted by a number of scholars (Vaze et al 2010). It is evident that higher resolution DEMs produce better results. Hanuphab et al. (2012) demonstrated this by using DEMs of different resolutions to model stream network and catchment of Phuket province, Thailand. They observed that higher resolution has the potential of yielding accurate results. Figure 9 is a DEM of the study area clipped from a single tile downloaded from SRTM (free download).

A comparative DEM was acquired from Google Earth which provides high elevation data using the virtual globe system. The process of creating the DEM from Google Earth involved importation of Google elevation data into a

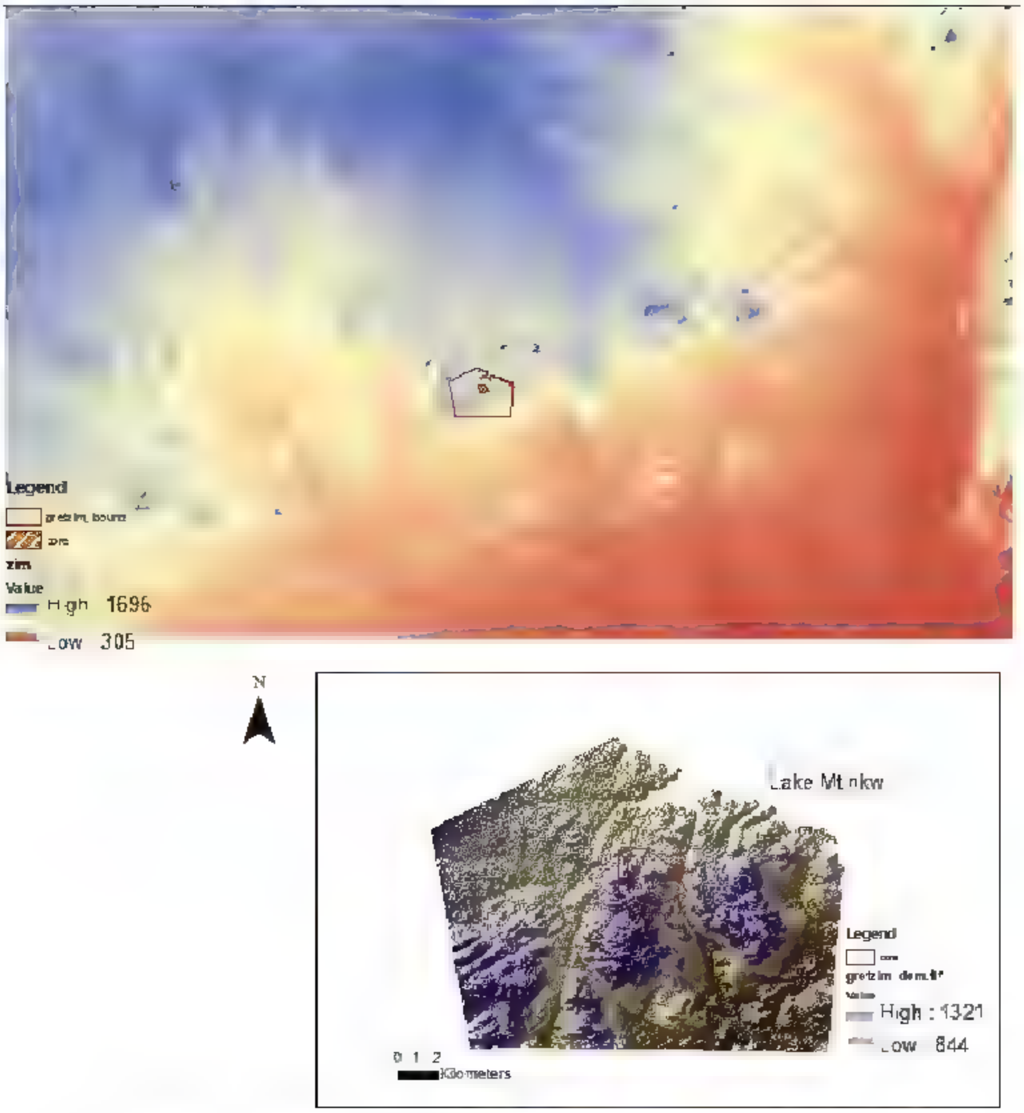



**Figure 9: Digital Elevation Model from SRTM 1arc sec data and the clipped DEM of the study area.**

usable GIS format for use in ArcDesktop. From the point data on Google Earth, a high resolution contour map and a DEM was generated in GIS The resolution of DEM has an impact on the results of the modelling process These DEMs in most cases are collected not specifically for hydrological modelling. Hutchinson (1989) argues that the DEMs are usually from scattered elevation data and usually these are produced as general purpose. These DEMs end up being the basis for the hydrological models. As a result of widespread availability of the digital elevation data over the internet, this limitation has since been resolved. Although not meant for hydrological modelling, DEMs can be used with a certain level of confidence owing to the high resolution associated. The data acquired was automated and prepared for modelling and analysis

**3.5 Data Analysis Methods**

The study employs GIS as a key method in the analysis of spatial data. GIS is defined by Rhind (1988) as a computerised system for collecting, checking, integrating and analysing information related to the surface of the earth. GIS has gained special favour in archaeology by providing systems for the management of archaeological data, and as a fundamental tool for the interpretation of archaeological contexts (Gallotti et al. 2011). It therefore offers interpretation of the site based on a scientific approach. GIS was used in the study to model water and related processes at Great Zimbabwe. There are a number of GIS software, both commercial and Free and Open Source Software (FOSS). ESRI ARCGIS 10.1 was used for this purpose. GRASS GIS software was in some instances employed as an analytical tool mainly to compare and verify results produced by the ARCGIS, but the major software employed was the ESRI ArcGIS. It should be emphasised that the study is not about GIS, but uses it to understand the processes that were shaping the spatial patterning exhibited in the archaeology of Great Zimbabwe. The analysis of data for the research drew methodology from a number of spatial analysis approaches, among them, hydrological modelling and cost surface analysis

The analysis was done in ESRI GIS programme with some adds-on software. The adds-on in this case was the Terrain analysis using Digital Elevation Model (TauDEM) which was used for hydrological modelling. The TauDEM enabled the automation of watershed delineation as well as the hydrologic modelling. It helps in understanding water management. In this context, it was used to analyse surface run off at the ancient city of Great Zimbabwe. Run-off models can be used to predict stream flow. Rippon and Wyness (1994) refer to the predicted stream flow as a major determinant of the 'hypothetical' flow.

### *3.5.1 DEM Conditioning*

Before using a DEM, it is imperative to recondition it to suit the needs of the research. This process involves 'pit removal' to make the DEM suitable for the extraction of a connected drainage system. A typical DEM contains sinks and pits. These are 'artificial' depressions that are found on the earth's surface. These make it difficult to use the typical DEM due to the fact that these pits disrupt surface topography in that water that flows in is not allowed to flow out during the modelling process. The sinks and pits disrupt the simulated flow of water (Connolly and Lake 2006: 329). This therefore makes it vital to remove sinks and pits before using a DEM. Pit removal is a function that enables the production of hydrologically correct DEM by raising the elevation of pits to the point where they overflow the lowest point (pour point) and can drain to the edge of the area. Pit removal was made possible through a process that artificially raises the height of neighbouring cells so they do not inhibit the delineation of drainage channels. The method however is cognisant of the fact that there are natural pits in the landscape. The challenge in this case, as argued by Connolly and Lake (2006), is how to remove only those pits that are not there in reality. According to Hutchinson (1989), the removal of pits and sinks is really based on the assumption that they rarely exist in the natural world

DEM conditioning also involved 'burning in' of streams which entailed the lowering down of known stream points on the DEM. The known rivers were obtained from topographic maps obtained from websites, free of charge. The river network was also used as reference. The sinks could be identified by map algebra where the original DEM was subtracted from the one that had the removed pits (Figure 10)

### *3.5.2 Hydrological modelling*

Water and its significance to society is studied in the same way any form of artifact is studied. From an anthropological perspective, Mosse (2008: 939) argues that 'water potentially provides the same basis for comparative analysis as kinship, food, land tenure or other centre pieces of anthropology as a cross-cultural discipline'. The potential of hydrological modelling is also highlighted by French et al. (2012: 29) who argues that it is capable of 'detecting periods of stress within a community, estimating

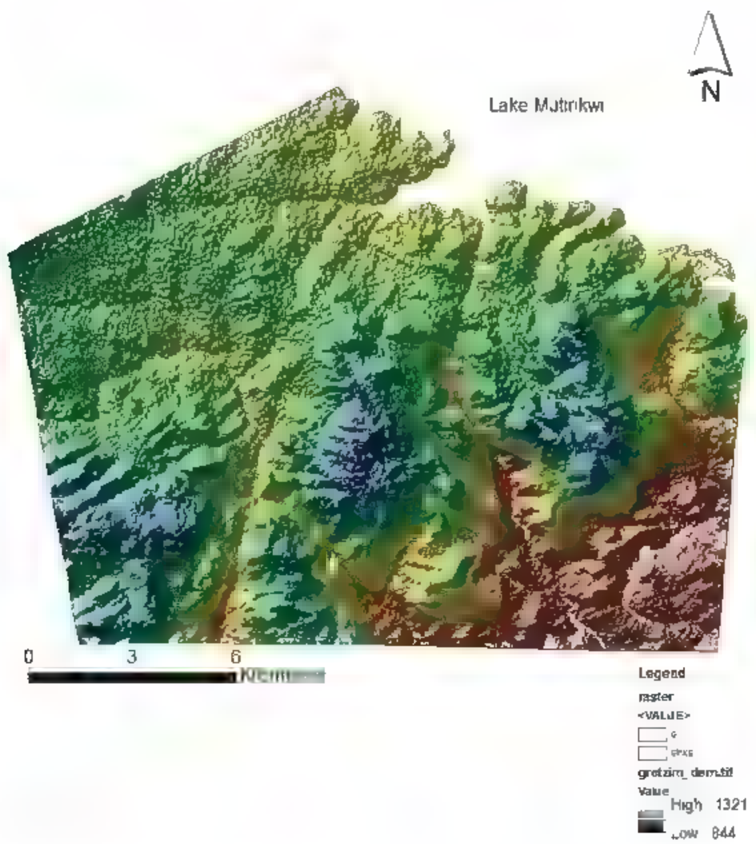



**Figure 10: DEM of the study area showing sinks in white.**

population by developing caps based on the availability of water, and understanding settlement patterns, as well as assisting present local populations in understanding their water cycle'. Understanding water processes sheds light on how it is managed. Paleoenvironmental study on past fluvial processes is usually critical in understanding the hydrology of archaeological phenomena. In the absence of such a study, hydrological modelling remains one of the best methods to understand the relative availability of water at Great Zimbabwe. The study used physical environmental data to produce hydrology models Hydrology models are defined as simplified conceptual representations of a part of the hydrological cycle

The first step was the delineation of catchments by determining the ultimate flow path of every cell on the landscape grid in GIS. The flow accumulation was then used to generate drainage based on the direction of flow of each cell. The approach of using hydrological modelling is appropriate for a study which is particularly interested in understanding spatial phenomena as these models 'can account for spatial heterogeneities and provide detailed description of the hydrological processes in a catchment' (Andersen 2008· 2). Hydrological models are also appropriate for the study as they allow for the delineation of catchments of sites using watersheds and streams or rivers (Dingman 1994; Sui and Maggio 1999; Tarboton 1997) Hydrological models have also been found to be useful as site predictors with respect to water harvesting, subsistence agriculture and water confluences (Harrower2008, 2010) Apart from the functions stated above, hydrology models have also been found to have a potential in aiding better site conservation through modelling of erosion processes which in turn aid in paleoenvironmental reconstruction. Through the use of GIS, researchers have undertaken in-depth analyses aimed at generating significant new understandings of ancient human use of water. As observed by Harrower (2010), GIS-based analysis, coupled with advances in remote sensing techniques have greatly improved archaeological inquiries Research has moved from characterising the physical environment to revealing how ancient peoples conceptualised and manipulated their surroundings.

In the process of hydrological modelling, the research was aware of the complexity of surface water. The complexity is brought about by other components that affect surface water. Evaporation and percolation as well as the flow environment all affect the direction of surface water The complex nature of the water system can be overcome in GIS, and this was achieved by inputting detailed surface features, depressions and vegetation cover in the study area. Thus, the application of GIS in the analysis of spatial phenomena has greatly aided in circumventing some of the challenges that had been encountered while using traditional methods of creating landscape models.

The author is aware of the problems associated with the use of hydrology models. All models are simplified versions of reality. They cannot contain all the intricate mechanisms and interactions that operate in natural systems However, the use of models in archaeological investigations is unavoidable. Due to the complexity of the past, working through models is the only way of approaching explanations and experimenting with the meaning of observed data (Lock 2003: 147). There are also technical challenges, which mainly stem from the data that is used to produce these models One of the technical challenges relates to the quality of Digital Elevation Models.

One of the challenges faced in hydrological modelling in archaeology is that of environmental determinism. This has been regarded as a major criticism of the use of GIS in general where in most cases studies end up being environmentally deterministic. The use of regression models for predictive modelling is usually viewed as particularly environmentally deterministic. The concept of environmental determinism posits that human activities are greatly influenced by the surrounding environment (Gaffney and van Leusen 1995; Kvamme 1997). Witcher (1999) asserts that due to large amounts of environmental data involved, such confusion often promotes excessive environmental determinism. Witcher (1999) also argues that GIS can move beyond description to provide an interpretive environment grounded explicitly on the developments in landscape theory. Witcher (1999) also acknowledges that GIS is beginning to be humanised, with applications such as the line-of-sight and least cost paths that deal with perception. As such, the argument that GIS is environmentally deterministic is increasingly becoming incorrect On hydrology models, Wheatley and Gillings (2002) assert that in the real world, there are several factors that affect drainage such as changing land-use patterns and construction of some structures which are not considered when reconstructing hydrology models.

### *3.5.3 Cost Surface Analysis*

Cost Surface Analysis is another analytical method adopted in the study. In Cost Surface Analysis, each cell contains the energetic cost of travelling which has been used to measure cost distance between features in the landscape and to estimate paths of least cost between points (Hare 2004). According to Llobera (2000), cost surfaces have generally been used to model movement on the basis of the cost incurred to travel to a certain destination. The study uses Cost Surface Analysis to obtain the least cost paths from water resources identified to various archaeological dwelling places The method was also used so as to test the routes that have been proposed for the site The tendency in coming up with cost surfaces has been reliance on slope, a topographical variable. Howey (2007) emphasises the need to use several variables in doing Cost Surface Analysis. Variables such as topography, vegetation and cultural impediments have an effect on what eventually becomes the 'optimal path' between an origin and a destination. Despite these other factors, Llobera (2000) argues that topography is an influential variable Thus, the cost surface analysis for the study was modelled on the basis of topography. The analysis took into consideration

the fact that the relationship between slope and effort is non-linear, and that change in one variable does not always bring about the same change in other variables. If cost surface models are created without this consideration, the result is a linear model where traversing a slope of 20° is taken to be 20 times more than a 1° slope. Relative costs increase steeply with slope angle and the relationship can be expressed mathematically (Bell and Lock 2000) The least cost paths were then modelled following Bell and Lock (2000)'s mathematical formula.

Another consideration is the concept of isotropic surfaces which assumes that the effort of travelling is the same in all directions, irrespective of whether one is going uphill or downhill The problem of isotropic surfaces was resolved by the use of anisotropic cost algorithm, which makes cost (effort) dependent on the direction and other attributes such as aspect (Connolly and Lake 2006). This partially solves the problem as it assumes that descending steep slopes is easier, which is not the case in the real world. Bell and Lock (2000) argue that descending near perpendicular slopes (of more than 25°) can be as tiring as ascending and 'descending a slope of 50° can be more of a tumble than a controlled perambulation' (Bell and Lock 2000: 90) Thus, a user defined function was employed to deal with near perpendicular angles

### *3.5.4 Catchment Analysis*

Apart from the above tools, the study uses some of the concepts of catchment analysis introduced in the 1970s by Vita-Finzi and Higgs (1970) Drawn from geomorphology, where the term has been used to refer to a drainage basin, the catchment in archaeology refers to the area that inhabitants derive their resources from (Vita-Finzi and Higgs 1970). Since its inception, several archaeological studies have employed the approach GIS technologies have also greatly aided in the adoption of catchment analysis so as to understand humans and their environment Catchment analysis involves relating an archaeological site to the surrounding physiography and simultaneously defining the limits of influence of an archaeological site The study makes the assumption that was proposed by Vita-Finzi and Higgs that a human group will in the long run make use of those resources within its territory that are economic for it to exploit and that are within reach of available technology (Vita-Finzi and Higgs 1970:2) Catchment analysis has its roots in economic spatial theory which, according to Rood (1982), is analogous to the well-known 'principle of least effort'. The economic spatial theory assumes that 'man is a rational animal ... and that ... will make choices and decisions which minimize cost and maximize profits' (Rood 1982: 28). The basis for catchment analysis is that 'human beings are refuging animals rhythmically dispersing from and returning to a central place differentially using [a] seasonally and spatially variable landscape that generally is conservative of energy' (Tiffany and Abott 1982: 314) According to Rood (1982), the root of all spatial theories is locational theory which emphasises the law of diminishing returns Grant et al (2008) claim that catchment analysis was one of the methods borrowed from economic geography and it is based on the assumption that settlements were not randomly located but located in such a way that they maximised efficiency and reduced effort in gathering resources.

In archaeology, catchment analysis has been used in the general description of the environment around a site in order to understand prehistoric economies and resource potentials of sites It has also been used in analysing settlement patterns and developing predictive models of site location. Site modelling, on the other hand, is based on the assumption of least cost where humans are seen as situating their activities in such a way as to conserve the amount of energy needed to access or distribute resources. It then follows that as long as archaeologists seek to understand economies of past societies and how humans interacted with the environment, catchment analysis is a vital method. As a result, this study also deployed catchment analysis to analyse the centrality of water at Great Zimbabwe Using catchment analysis principles, the study also addresses issues of population size at Great Zimbabwe. Matthews (2003: 171) maintains that understanding the economic potential of an area offered by site catchment analysis has the possibility of generating insights and ideas about population levels by estimating the carrying capacity Carrying capacity is a concept that links resources and population, and water being one of them, site catchment analysis was used

Traditionally, site catchment analysis used arbitrary boundaries. The use of arbitrary boundaries has caused a lot of contention among scholars who mainly argue that boundaries are determined by various cultural variables Culture determines both time and distance such that imposing a limit or a cut-off can be easily faulty (Rood 1982). In this case, site catchment is used to obtain data on the 'physical settings of prehistoric settlements which can supplement botanical and faunal data from excavations' (Dennel 1980). This capability has been made possible through the use of GIS tools such as cost surface analysis. Using cost surface analysis, boundaries of any shape can be created, depending on the nature of the terrain and other cultural variables. Cost surface analysis has been used to model movement on the landscape.

### 3.6 Conclusion

Archival research, ethnohistorical accounts and archaeological surveys proved to be efficient tools in the acquisition of data needed in quantifying water sources and understanding its management, as well as landscape history at Great Zimbabwe. Aerial photographs, ministry documents and springs were some of the data that were obtained using the various research methods that have been stated in this research. Gathering sufficient data to input in a GIS program for analysis is critical in that it works with the principle of 'garbage in', 'garbage out'. The quality of results is determined by the quality of the

data which in turn relates to the relevance of the deployed data acquisition methods. The GIS provided a platform of 'getting into the unknown' by simulating physical and cultural processes such as movement. The methods used in the study situate it within the broad theoretical framework of landscape archaeology, which is critical in understanding water and movement within the landscape.

# 4

# Ethnography, Landscape, Water and Great Zimbabwe

## 4.1 Introduction

This chapter draws on ethnographic and archival sources in order to provide a depiction of the water supply situation at Great Zimbabwe. To understand archaeological water consumption and water management systems at Great Zimbabwe, it is important to analyse the ethnographic present. In particular, it is important to examine contemporary water management and consumption patterns in communities and settlements around Great Zimbabwe such as Nemanwa Growth Point, Morgenster Mission and surrounding villages. These settlements have continued to make use of some of the water sources such as springs, wells and rivers that were evidently used by people at Great Zimbabwe. The map below (Figure 11) shows some of the active and inactive springs in the area The study was premised on the view that contemporary water challenges and water management systems can provide lens through which one can analyse the centrality of water when Great Zimbabwe was occupied. By using the ethnographic present to understand water use and management in the archaeological period, the study is not suggesting that the environment has remained unchanged since the time Great Zimbabwe was occupied. Many

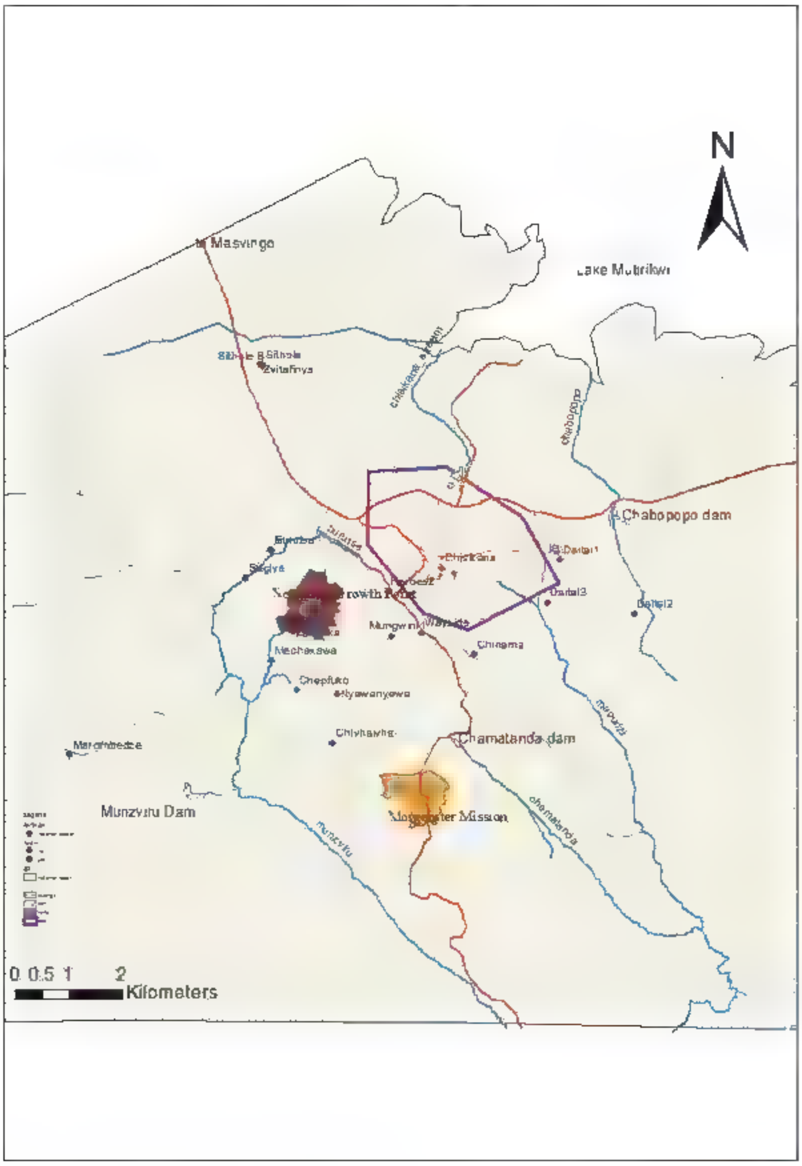



**Figure 11: Water sources (rivers and springs) within the study area.**

scholars have argued that environmental changes like degradation leading to ecological disasters may have contributed to the demise of Great Zimbabwe (Bannerman 1982; Garlake 1973; Huffman 1972; Pikirayi 2006). This suggests that the landscape has changed over time In spite of this, contemporary water challenges, traditional water management systems and indigenous knowledge systems can help in appreciating the role played by resources such as water in the development of Great Zimbabwe, especially in the everyday life of residents of the city and those who visited it. This helps in understanding Great Zimbabwe as a lived city rather than an abandoned one. Environmental trends and how the landscape of Great Zimbabwe has changed over time are also critical elements that will be discussed in this chapter These changes provide insights into how the water situation at the site could have been affected by the various activities.

**4.2 Water at Great Zimbabwe in Historical Accounts, 1890-Present**

The Great Zimbabwe landscape is characterised by springs sustaining water demand throughout the dry season and during droughts. Currently, most of the streams are ephemeral, with water flowing only during the rainy season. However, it is well documented in historic literature that some of the streams used to flow all year round (Bent 1893; Hall 1905a; Hall and Neal 1904) Commenting on the general location of the Zimbabwe culture sites, White (1901: 21) echoes that the builders seem to have preferred an agricultural country with positions easily defended. The availability of water is considered to be among the characteristics of a defensive location. Hence, it is expected that Great Zimbabwe had to have a reliable water supply to be a desirable and sustainable settlement.

Mutirikwi and Mushagashe rivers are the two major rivers close to Great Zimbabwe mentioned in historical records However, in spite of the mention of these rivers by literate observers in the late 19th century and early 20th century, there is no mention that water for daily use was obtained from them. An example of these early texts is the report by Major Sir John Willoughby, who, in describing the locality of Great Zimbabwe, highlights the major features around the site. He highlights that Mushagashe River 'flows south eastwards, a distance of about 4 miles from Great Zimbabwe' (Willoughby 1893: vii). Even though this river is a few kilometres from the settlement, Hall (1905a) argues that possible sources of water for Great Zimbabwe did not include the Mushagashe River but rather the marshy tracts along the tributaries of the river

Chabopopo is another notable perennial stream mentioned by early writers. In describing the stream, Hall (1905b) stresses that it was perennial and sourced from the Boroma range. He also highlighted the fact that the stream drained into the Mushagashe River. The stream was used for agricultural purposes by some European and Asian farmers in the early 1900s. Hall (1905a) makes reference to Naidoo, an Indian farmer who had an extensive market garden in Oatlands farm. Early texts also mention a stream which drained the valley between the Great Enclosure ('Temple') and the Hill Complex ('Acropolis') (Hall and Neal 1904; Hall 1905a). Thus, it is evident that Chisikana spring and some ephemeral streams around Great Zimbabwe were the major sources of water for this ancient city. However, it is also evident that these sources were ephemeral and therefore unreliable sources of water especially during periods of severe droughts.

Despite the fact that there were a number of rivers and streams around Great Zimbabwe, it is evident from historical documents from the late 19th and early 20th century that Great Zimbabwe always had water challenges. Records produced by early curators of Great Zimbabwe are full of complaints about water shortages For example, a curator at the site, Claire A. 'Shumba' Wallace's correspondences are replete with complaints about the challenges he faced fetching water with his cart in the 1920s Fontein (2015) points to several of Wallace's letters in the late 1920s where he pleaded with the Public Works Department to work on the water supplies for the period between August and November, the driest time in the country. In a letter addressed to Nevile Jones, the then Curator at Great Zimbabwe, the intention to put a water pump near the spring (presumably the Chisikana spring) in 1948 was highlighted There is evidence indicating that in the 1940s the Chisikana spring was not perennial. A letter written by the Curator at Great Zimbabwe in 1948 stated that despite significant downpours, the spring was yet to run properly. This indicates that Chisikana spring was never a reliable or sufficient source of water for Great Zimbabwe. This shows that the water sources around Great Zimbabwe were largely ephemeral.

Apart from curators, managers and workers at the nearby Great Zimbabwe hotel also had to deal with the almost perennial challenge of getting a consistent supply of water for the hotel clients. The first water source for Great Zimbabwe Hotel was a borehole. As early as the 1940s, efforts were made to establish a more reliable water supply for the monument and the hotel Of interest to note is a complaint that was raised in 1950, addressed to the Office of the Magistrate, which highlighted the scarcity of water at Great Zimbabwe. The letter highlighted that residents at the hotel had been unable to bath as water had to be carried by cart from a river six miles away It was because of these erratic water supplies at Great Zimbabwe that the Internal Affairs Department was asked to prioritise the water supply at the then Zimbabwe Ruins Hotel To satisfy water needs at the monument and the hotel, water was sometimes drawn from the Morgenster Mission farm run by the Dutch Reformed Church, using water carts.

In the 1960s, the Department of Works installed a water system at Great Zimbabwe drawing water from two boreholes, which had yields that were below expectation. In addition to the dismal performance of the boreholes, they were found to be negatively affecting the marsh in the 'Watergate' area. This led to the discontinuation of borehole

water use partly due to its impact on the environment Consequently, the authority decided to build Chabopopo dam in the early 1970s to supply adequate water to the settlement which included the hotel and the monument The Chabopopo dam was efficient up until the early 1980s The construction of the dam was a short-lived solution to the water crisis at Great Zimbabwe After 1980, there was drought coupled with the resettlement of Oatlands and Le-Rhone farms which led to the establishment of the Oatlands irrigation scheme.

Currently, water for daily use at Great Zimbabwe and its immediate surroundings which include Nemanwa Growth Point and Great Zimbabwe Hotel is drawn from Lake Mutirikwi (formerly known as Lake Kyle) and occasionally from the Chabopopo Dam. The Zimbabwe National Water Authority (ZINWA), a government agency which manages and distributes water in the country, is responsible for the distribution of the water from the dams. Lake Mutirikwi was constructed initially to serve the water needs of sugar plantations of the Lowveld of Zimbabwe, some 250km to the south east. The dam project can be traced to the ambitions of Thomas Murray McDougal who, after initially visiting the South-Eastern Lowveld in 1912, started sugar cane production in the 1920s (Saunders 1977).

The role played by McDougal in the establishment of the South-Eastern Lowveld Sugar estates is, however, debated with some scholars arguing that it mirrors the 'hero leaders' of the Rhodesian discourse. Narratives of the establishment of the Lowveld sugar plantations by Thomas Murray McDougall are cited as an example of these constructions (Wolmer 2007). Despite these debates, it is recognised that in 1937 McDougal milled tons of sugar and thereafter there was expansion of the irrigation scheme. The estate then passed through several hands until 1958 when it was taken over by Hulletts and Sons The Rhodesian government was initially pessimistic on the dam project but later engaged in a development plan where it agreed in part to build Kyle dam to supply sufficient irrigation water in the future and the dam was finally constructed The dam was completed in December 1960 and officially opened in 1961 Some sceptics argued the dam wall was too high leading to speculation that the dam would never fill up. In 1974, the dam recorded its first spill. The filling of Lake Kyle was a momentous event not only for Fort Victoria residents but also for Rhodesia in view of previous pessimism as to whether the lake would ever fill up. In spite of this event, the lake together with other smaller dams in the region such as Bangala and Manjirenji have been struggling to have sufficient water to service the sugar plantations

To avoid the overuse of Lake Mutirikwi, the government began the Tokwe-Mukosi dam project in 1998 The dam was completed in December 2016 and has since overtaken Lake Mutirikwi as the largest inland dam in the country with a capacity of 1.8 billion cubic metres. The dam is strategic in alleviating water shortages in the Lowveld sugar plantations, which could not be sustained by existing dams Thus the water currently used at Great Zimbabwe and its immediate environs was initially meant to serve sugar cane plantations in the Lowveld of Zimbabwe. Chabopopo dam on the other hand was built specifically to serve the water needs of the hotel and the monument in the 1970s

The decision to draw water from Lake Mutirikwi by the Nemanwa Growth Point and Great Zimbabwe was initiated in 1995 after a series of droughts and the rapid expansion of the Nemanwa Growth Point had led to a water crisis in the area. The 1995 drought, in particular, resulted in a critical water shortage. It is this crisis that forced various government departments to convene a series of meetings aimed at addressing the water challenge. To ensure the smooth running of the project, a water steering committee comprising management from Great Zimbabwe Monument, Great Zimbabwe Hotel and Nemanwa Growth Point and other interested parties was set up. Among the highlights from the meetings was that the whole of Shepherd's Plot (now Lodge at the Ancient City), Great Zimbabwe, Morgenster and Nemanwa Growth Point were suffering a domestic water shortage At that time, Great Zimbabwe Hotel, Great Zimbabwe Monument and Nemanwa Growth Point drew water from the only two boreholes which were located in the monument area The boreholes were overworked by the high expansion of Nemanwa Growth Point and Shepherd Lodges (Lodge at the Ancient City). Various proposals were put in place, among them, the construction of a dam in Mzero farm, north-west of Great Zimbabwe

The idea of a dam in Mzero farm was shelved on the basis that all dams in the Masvingo region were performing dismally as a result of poor runoff, which had been experienced over the years. A report presented in one of the meetings indicated that the initial government plan to ease water crisis in the area was to construct a dam along Munzviru River, which failed mainly due to financial challenges.

One of the solutions to the water problems in the 1990s was the drilling of more boreholes However, the drilling of boreholes was considered a short term measure as the geophysicists who had been tasked to survey the area had indicated that the whole area had poor prospects for underground water as evidenced by the poor yields of the existing boreholes. A recommendation was passed that no other borehole should be drilled as they could adversely affect the Watergate swamp. These water challenges arguably reflect the centrality of water in the everyday lives of people who lived in this ancient city during its peak between the 13th and the 15th century. It is clear that there was need for good and reliable water sources for the city to run smoothly and also a sound water management system.

Against the background, it was finally agreed that the only lasting solution to the water problems would be for all the

communities around Great Zimbabwe to draw water from Lake Mutirikwi The process started in 1996, and by the year 2000, the water treatment plant located a few metres east of the Great Zimbabwe Conservation Centre had been put in place Up to the present, domestic water for Great Zimbabwe and the nearby areas is still sourced from Lake Mutirikwi. However, the water supply from Mutirikwi remains erratic due to the fact that the water is mainly used for sugar cane irrigation in the South Eastern Lowveld This has made the communities to turn to the Chabopopo dam which is much smaller and is also used for a small-holder irrigation scheme.

The water consumption at Great Zimbabwe and Nemanwa Growth Point has also increased over the years and has exceeded the water pump capacity. The 2012 census estimated the population of Nemanwa Growth Point, Morgenster Mission, Great Zimbabwe and surrounding communities to be 10000. Most of Nemanwa Growth Point residents get their water supplies from ZINWA. The area falls under the Runde Catchment Area, with a substation 200m east of the Great Zimbabwe Conservation Centre. This substation is responsible for reticulating water from Lake Mutirikwi as well as Chabopopo dam. The station controls more than 1000 water metres around Great Zimbabwe though the actual figure could not be ascertained. These are categorised as bulk and individual Among consumers with bulk metres are Great Zimbabwe Monument, private and public business such as hotels and lodges, local municipal houses, health centres as well as schools (Pikirayi et al. 2016: 203). An individual household consumes between 20 and 30 cubic metres of water per month. This water supplied by ZINWA is largely for cooking, drinking, washing and gardening Disruptions of water supplies is sometimes a result of equipment breakdown attributed to obsolete pipelines and the pumping machine This renders supply of piped water from ZINWA unreliable to the extent that almost every household has resorted to using water storage tanks There are also two boreholes sunk by ZINWA, which are used as alternatives during the water cuts. Residents from Nemanwa also resort to springs dotted around the area. It is the use of the springs that sometimes results in conflicts between their traditional custodians and residents of the Growth Point. During the 1992 drought, for example, there was a clash on the use of Burutsa, a perennial spring, north-west of Nemanwa Growth Point. Besides Burutsa, reference was also given to Machakawa spring, which is one of the perennial springs and does not dry up even during droughts.

#### *4.2.1 Ethnography of the Chisikana Spring*

From early records by European travellers and explorers as well as from oral traditions, it is evident that there was a spring at Great Zimbabwe which was one of the most important sources of water in the city. Hall (1905a) reported the presence of a spring on the northwest side of the Great Enclosure Although the European records such as Hall (1905a) did not mention the spring by its name, it is clear that they were referring to Chisikana spring. The spring is located some 200 metres to the north-west of the Great Enclosure. Although it is no longer running, the Chisikana spring remains a sacred water source for the Nemanwa and the Mugabe clans (Fontein 2015). The Nemanwa and Mugabe clans have often fought over ownership of this spring Both clans deploy oral traditions and charter myths to cement their claims over the spring and by extension authorship and ownership of Great Zimbabwe. The two clans have competing oral traditions on Chisikana spring and why it is considered sacred. For the Mugabe clan, the spring is sacred and associated with *njuzu* (mermaids) spirits. They recall a charter myth concerning one of the great aunts of the Mugabe clan (*vatete Chisina*) who disappeared at the spring presumably after having been taken by a mermaid living in the spring The Mugabe clan say that the spring is where their great aunt, *vatete Chisina*, a young girl sent to fetch water at the spring, was abducted by a mermaid, never to be found (Matenga 2011: 106) The Nemanwa clan argue that the spring is where the clan originated from. In their traditions of origin, the Nemanwa clan are said to have 'germinated' (*kumera*) from the spring which is why they refer to themselves as '*vameri*', meaning those who germinated For the Nemanwa clan, the spring is at the centre of a foundation myth, a great grandmother, *Chisikana*. She was a young girl found sitting at the spring, her origins unknown. Nemanwa adopted and later married her to become the 'mythical' progenitor of the clan. Stories surrounding the Chisikana spring were used to maintain the sacredness of the spring and at the same time, this sacredness was a management tool for the spring

Early amateur archaeologists and explorers who visited Great Zimbabwe such as Adam Renders and Karl Mauch reported on the significance of the Chisikana spring. Hall (1905a) reported that the location of Chisikana spring was marked by a group of trees and that the spring was a source of the 'most excellent' water even during dry seasons. The dense vegetation referred to was probably a result of the high soil moisture content on the location of the spring However, later reports suggest that the spring was not perennial, indicating that it might have been affected by environmental changes

In the 1950s, curators of Great Zimbabwe made a decision to seal the spring with concrete This was done as part of the landscaping of a golf course established at the monument (Matenga 2011). The golf course was established on the western side of the Hill Complex, below the Watergate paths These developments caused a lot of grief to the local communities who considered the spring to be sacred

Efforts to resuscitate the Chisikana spring were started in the 1990s by curators at Great Zimbabwe. However, the clashes between the Nemanwa and Mugabe clans over ownership of the spring impeded the process. One such effort was a ritual cleansing ceremony in 1995. The ceremony was attended by spirit mediums (*masvikiro*) from three clans, Nemanwa, Mugabe and Charumbira.

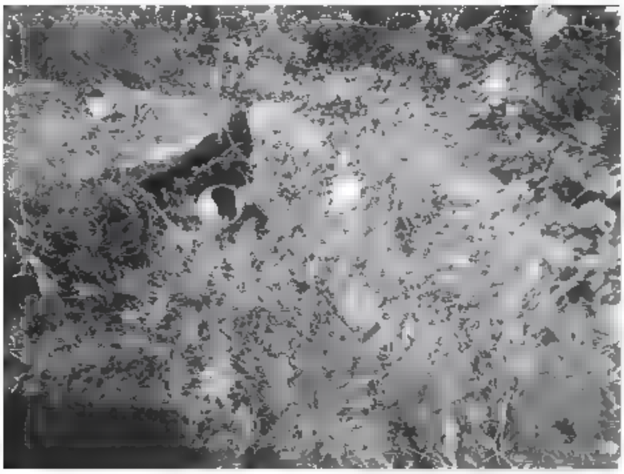


**Figure 12: The once active Chisikana Spring (photo by the author).**

According to Fontein (2008), instead of collaborating with each other and focussing on the spring, each clan was supporting its own spirit medium, with the ceremony turning into an ownership wrangle. Each clan was trying to prove they were the rightful owners of the site. The cement on the spring was removed and water briefly oozed out before completely drying out. Lack of unity among the spirit mediums is given as the reason for the failure to resuscitate the spring. Currently, what remains are indicators of a once wet environment. Some pointers to a once wet environment include the vegetation which is characterised by riverine vegetation such as the Waterberry (*Mukute*).

As shown above (Figure 12), the characteristic soil of Chisikana spring is humus. The site of Chisikana spring is also characterised by green grass, even when the surrounding is dry, a situation that is mostly an indicator of the high moisture content of the area. As evidenced by the presence of recently made clay pots, people still visit the spring to perform various rituals.

### 4.3 Landscape History in Memory

The landscape history of Great Zimbabwe can be reconstructed from the available photographs and oral accounts describing how this terrain has changed over time. It is of paramount importance that the landscape history be established so as to understand how the landscape has changed over time. In reconstructing such history, both aerial photographs and general photographs of Great Zimbabwe have been used. The information gathered relates to the landscape history of the area now declared a national monument. The site was altered by the different management regimes of the site (Chikumbirike 2014). The focus is on the changes that impacted on the site and its immediate environment. Although aerial photographs can potentially provide more detailed analysis of the landscape history, available photographs of Great Zimbabwe, particularly of the earlier periods, are scanty and the fact that they were not consistently archived makes it difficult to use them in isolation. Triangulation of aerial photographs with other photographs and sources is critical in obtaining more useful information of the landscape history of the Great Zimbabwe monument. The photographs used for the analysis date back to 1890s.


**Figure 13: 1941 aerial photograph of Great Zimbabwe showing one of the dhaka pits.**

Despite land-use changes, the photographs indicate that a number of features that we see today at Great Zimbabwe have been there since the site was made known to the outside world by early explorers and researchers. Among some of these features are the so called 'dhaka pits' on the western edge of the Hill Complex as well as the 'aloe garden' between the Hill Complex and the Great Enclosure. Thus, whereas other features can be attributed to 19th century alterations, there are some which have been there before the various activities were introduced to the site. Figure 13 shows an aerial photograph of part of the site showing the presence of a *dhaka* pit on the southern bottom of the Hill Complex.

There is evidence that the Great Zimbabwe landscape has gone through a number of changes with regard to land use. Early explorers and visitors to the site did not find people living within the core of the Great Zimbabwe but rather on the periphery of the site (Bent 1895: 84). An analysis of available aerial and 'general' photographs from the late 19th century period indicates that after the publicity given to the site, a number of developments then took place with construction of structures and eucalyptus plantations being the major ones. The structures that were initially constructed at the site were adobe (pole and *dhaka* huts). These huts were meant for both the local workers as well as early European settlers at the site. An example of such houses is Willie Posselt's homestead, which was located close to the Chisikana spring (Figure 14).

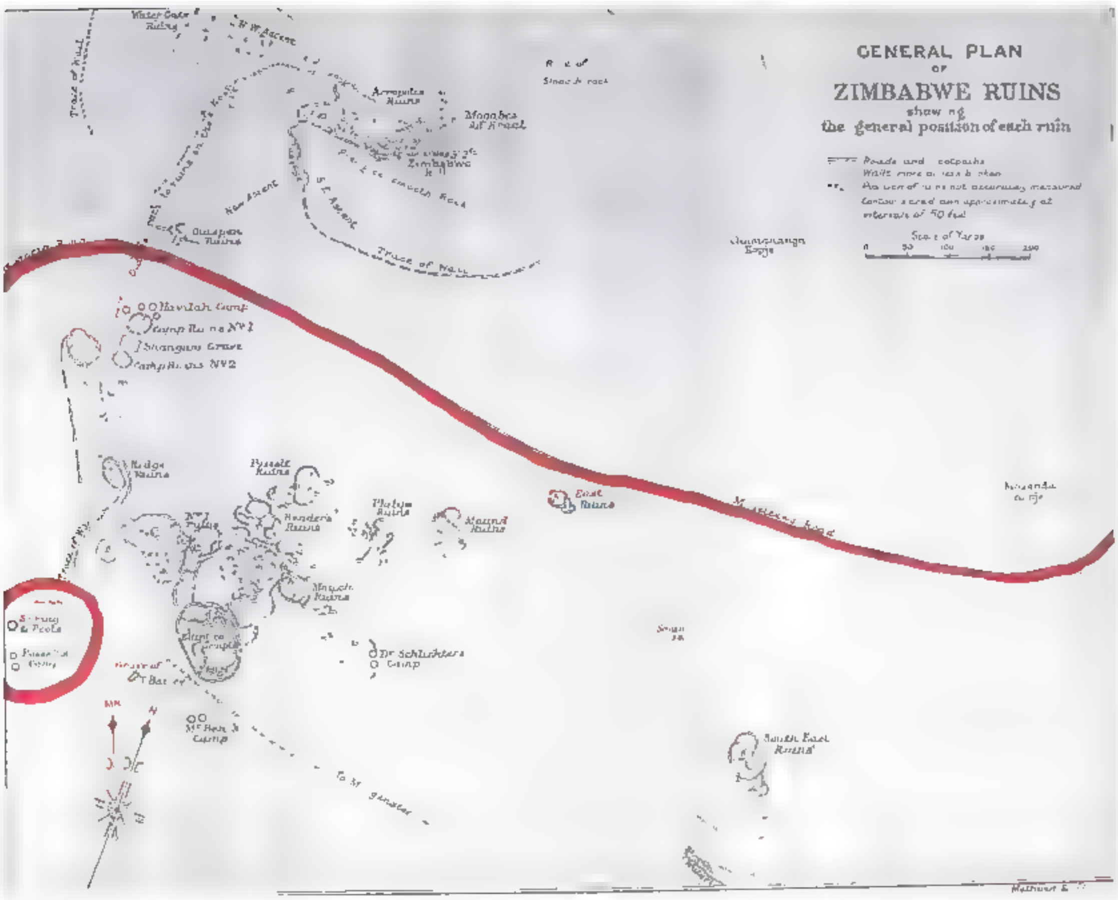



**Figure 14: Location of dwelling huts near the Chisikana spring (adopted and modified from Hall 1905b: 7).**

Some of the landscape changes that can be observed in the map (Figure 14) include a gravel road that passed through the monument to Mutirikwi. This road has since been re-positioned, skirting the monument.

With the passing of time, brick and cement structures were introduced. Again, most of these structures were meant for the workers of the National Parks Department who were responsible for the management of the site as well as those who catered for tourists' needs Included in the structures were, among others, a prison, which was established during the time the National Parks Department was in charge of the monuments, the Girl Guides hostels and the Great Zimbabwe Hotel which were all built in the monument area. By 1963, the prison, located behind the Great Enclosure, had become functional. The site was under the National Parks of Rhodesia but the prison was under the Prison Services of Rhodesia. There were three (3) separate blocks for prisoners and several others for prison officers. A fence was erected to provide security for prisoners. One of the reasons for having a prison inside the monument was to get labour for the maintenance of the site and also to support the long held notion that structures such as these were built using slave labour. Prisoners would cut grass and maintain roads among other manual jobs. In 1976, when management of the site changed from National Parks to National Museums and Monuments, the prison was moved out of the Great Zimbabwe monument.

Other developments which took place to cater for visitors included the construction of chalets within the monument area. The construction of these visitor facilities, even up to the present, has been a controversial issue with conservationists arguing that structures disturb the visual and environmental status quo within the monument. Figures 15-18 are photographs obtained from the National Archives of Zimbabwe and the Great Zimbabwe

**Figure 15: The almost 'undisturbed' Great Zimbabwe landscape, 1890 (Source: National Archives of Zimbabwe).**

**Figure 16: Landscape of Great Zimbabwe 1903 (Source: National Archives of Zimbabwe).**

**Figure 17: Great Zimbabwe, The Great Enclosure in the middle ground, 1918 (Source: National Archives of Zimbabwe).**

Conservation Centre showing the landscape changes at Great Zimbabwe since the 1890s

Figure 15 is a photograph which was taken presumably from the direction of the Hill Complex Here, there is fairly medium to dense bush and grass. The Great Enclosure is in the middle ground. The vegetation is dense to the extent that the valley ruins are partially obscured from the Hill Complex.

From the photograph above (Figure 16), it is evident that the Great Zimbabwe was surrounded largely by grassland and very few trees. The photograph shows considerable tree clearance, resulting in open woodland and grass. The valley ruins could be seen in this photograph. Notable is the absence of the aloes that currently characterise the area between the Great Enclosure and the Ridge structures to the west

The photograph of the Great Enclosure taken in 1918 (Figure 17) shows how in the early 1900s the site was characterised by savannah grasslands and a few mainly *Brachystegia* trees As later photographs taken during the second half of the century clearly show, most of the trees inside the Great Enclosure were later cut down except for a couple of red milkwood trees (*Mimusops decorifila, muchechete*) on either side of the conical tower

The aerial photograph taken during the 1960s (Figure 18) shows a prominent road leading to the Great Enclosure There is also the presence of several huts in the area occupied by the present day site museum. These were modern buildings which were meant for the managers at the site. In the middle of the photograph is a cleared piece of land which possibly was used for agricultural purposes To the right of the photograph is a Eucalyptus plantation, signalling invasion of the indigenous vegetation by foreign species during the time. Chikumbirike (2014: 175) attributes the differences in vegetation to the restrictions that are in place with regard to the fetching of firewood as well as grazing of animals. However, there are species such as White syringa (*Kirkiaacuminata, Mubvumira)* which has almost disappeared from Great Zimbabwe due to the

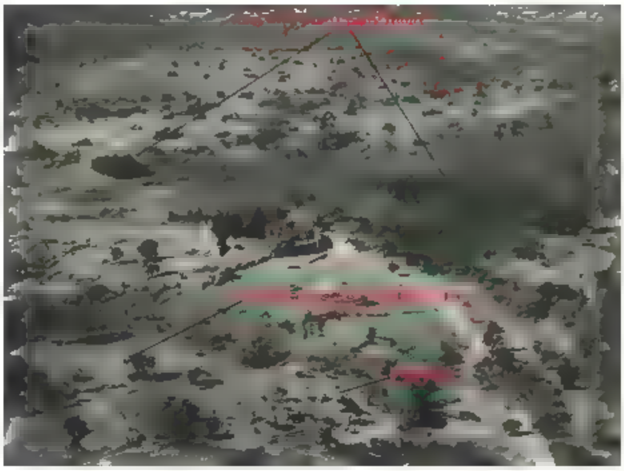


**Figure 18: Aerial photograph taken in the 1960s (source: Great Zimbabwe Conservation Centre).**

fact that the tree is largely used for sculpturing artefacts which are sold to tourists (Chikumbirike 2014: 175)

The area from the Mujejeje ruins up to the Lodge at the Ancient City (Figure 19) was wholly used for agriculture up until it was declared a National Park in 1936. The curator at the site used to plant maize and tomatoes in that area.

The utilisation of the land for agricultural purposes is supported by narratives from Hall (1905a) who makes reference to Naidoo, a farmer of Indian origin, who was already utilising the Chabopopo River for irrigation purposes and is said to have had an extensive garden in his Oatlands Farm. In 1893, Willoughby (1893) reported that there were fertile lands around Great Zimbabwe He observed that the land had potential to nurture the growth of a wide range of plants. Farmers were already supplying farm produce such as potatoes, cabbages and tomatoes It can therefore be said that at one point, agriculture was practised within the built area of Great Zimbabwe. There is also the mention of SlicJiter Gorge, 'a ravine a mile south west of Zimbabwe [in] which flows Mapudzi stream southwards' (Hall 1905a: 60). Owing to the abundance of water coupled with tall reeds during the rainy season,

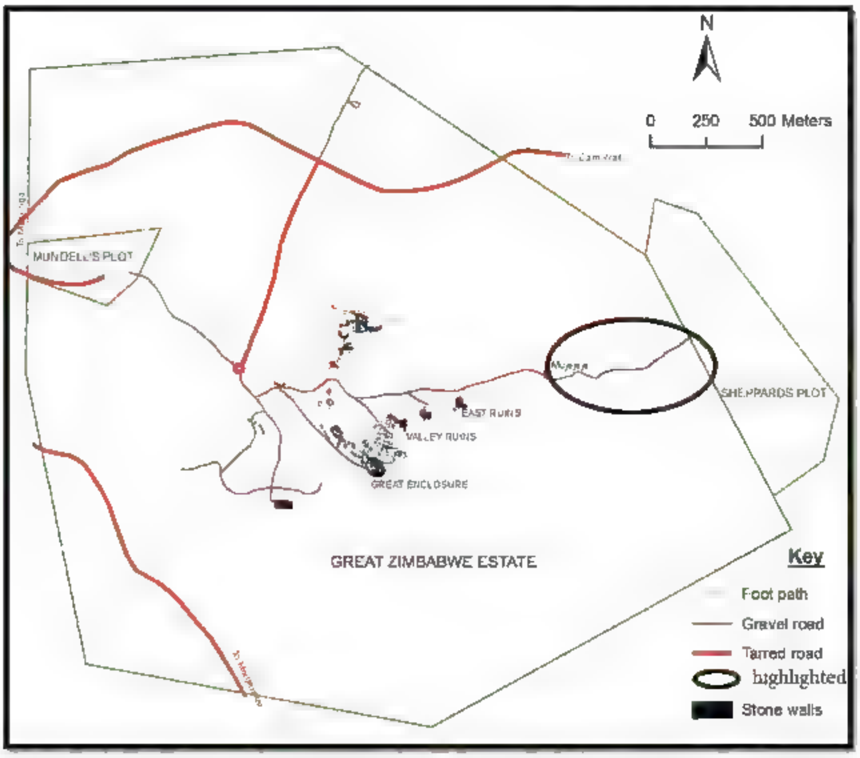



**Figure 19: The location of Mujejeje Ruins and Sheppard's Plot in relation to the built area of Great Zimbabwe.**

getting to this gorge was rendered impossible. The stream was however ephemeral, drying up in the dry season, except for a few pools of stagnant water.

One of the developments which impacted the environment around Great Zimbabwe was the planting of Gumtree (*Eucalyptus*) in the 1940s (Nehowa 1997). The area south and south west of the Great Enclosure had more of these plantations. The eucalyptus within the Great Zimbabwe monument has since been referred to as an invasive species which needs to be eradicated. In addition, the eucalyptus trees have a negative hydrological impact and may have desiccated the Chisikana spring. The process of eradicating eucalyptus, like the eradication of *Lantana camara*, has proved difficult due to the resilience of the trees. Hence, currently, the eucalyptus remains a challenge for curators and managers at the monument. A number of programs have been implemented to eradicate the species. Among these strategies have been Aztec and ZIRRCON tree planting programs of 1996 which saw the planting of indigenous trees at the site (Chikumbirike 2014: 174). Local communities are usually permitted to cut gum trees in and around the monument free of charge or at a small fee depending on the nature of the request. The idea of getting a permit to cut this species also shows reluctance by NMMZ to totally eradicate the species as they get some income from selling gumtree poles to the local community.

As highlighted earlier, one of the developments that changed the vista of Great Zimbabwe was the introduction and subsequent removal of the golf course in 1976. It was situated in the area between the Great Zimbabwe Hotel and the Hill Complex (Figure 20). The golf course is thought to have adversely affected the landscape of Great Zimbabwe to a larger extent as it is the one that led to the physical closure of the Chisikana spring. Besides the clearance of vegetation, some amenities were put in place to cater for the demands that come with maintaining a golf course as well as visitor needs.

The golf course caused a lot of disquiet among local communities as well as some members within the colonial government. Consequently, there were debates on whether the golf course had a place within such an important landscape as that of Great Zimbabwe. In the late 1970s, pressure for the removal of the golf course began to mount from both the Monuments Department and the general populace. In 1977, Mike Raath, the then Director of the Victoria Publicity Association, an organisation that represented the residents of Fort Victoria, once commented:

> the golf course had no place in a National Monument. It was totally out of place, obtrusive and unbecoming Added to which it lay directly on top of an important archaeological component of the ruins. Allowing this to persist invited censure from archaeologists all over the world.

Besides the contentious location of the golf course on the site, other factors that led to its ultimate removal from the monument area include the heavy expenditure associated with running it against the very few, if any, golfers who visited. However, the major reason for the closure of the golf course was that it altered the natural vista of the site and impacted negatively on conservation efforts. As Mike

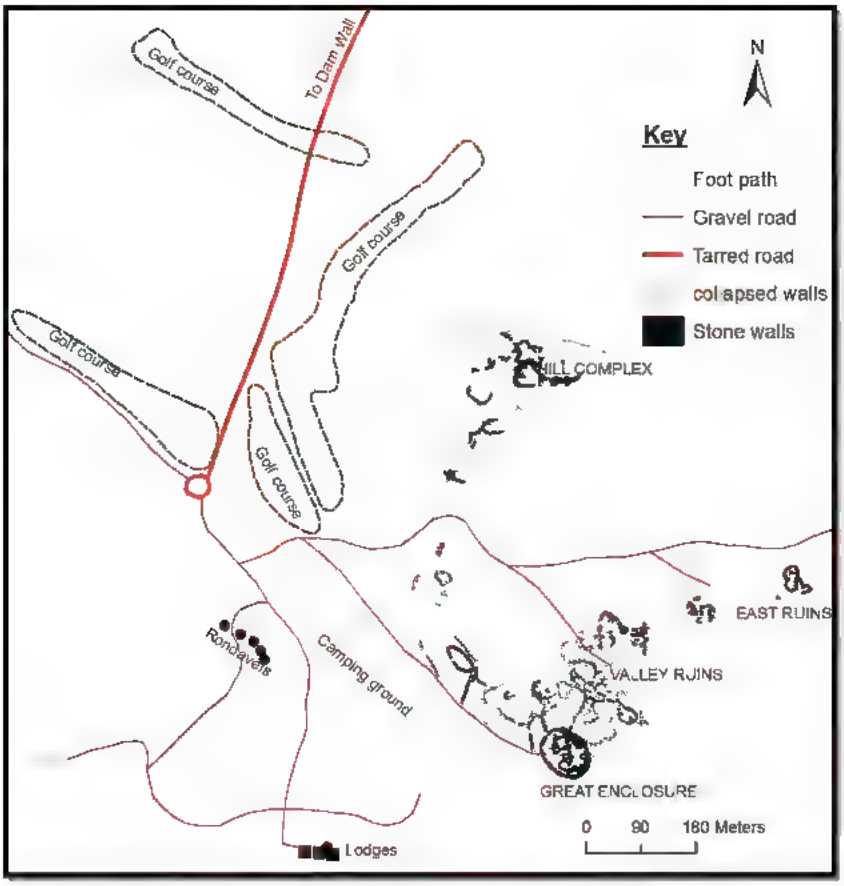



**Figure 20: Location of the golf course.**

Raath put it, 'heaven forbid that in a hundred years' time we are remembered for a superb golf course picking its way among the decaying and neglected remnants of what was once one of the world's famous prehistoric monuments' need for preservation of the site.' The golf course was thus a problem to both local communities and heritage managers

Between 1972 and 1976, Great Zimbabwe was jointly managed by the National Parks Department and the National Museums and Monuments Board This period witnessed a number of clashes between the two government departments. The Department of National Museums and Monuments argued that the need to develop the site for tourism had compromised effective management as well as the sacredness of the site. It was against this background that Mr W. van Riet, a landscape architect and park planner from South Africa, was contracted to make an assessment of the planning and conservation strategies that could be used at Great Zimbabwe and make recommendations. Among his recommendations was that the entire area be recognised as an interrelated entity and be regarded primarily as a national monument This meant that its control was to be vested solely in the National Museums and Monuments. He also recommended that all activities and land uses incompatible with the area's primary value should be eliminated and general tourist facilities provided outside the area. Ultimately this led to the National Monuments assuming the sole management of the site with a legal instrument, the National Museums and Monuments Chapter 25:11 being gazetted in 1972 One of the first tasks that the Museums and Monuments department had to deal with was the removal of the golf course from the monument

The construction of buildings using cement, the eucalyptus plantations as well as other auxiliary developments meant to meet tourists' expectations were considered to be affecting the hitherto pristine Great Zimbabwe landscape. Even the community beyond the confines of Great Zimbabwe had always been raising concern over the landscape changes at the site. As early as 1972, a number of people were already beginning to complain about the landscape changes which were brought about by building constructions and other projects in and around the monument

The drying of the Chisikana spring was as a result of landscaping to accommodate the golf course. Cement was used to seal the spring and also eucalyptus plantations were cultivated on the headwaters of the spring which ultimately blocked the underground streams which fed the spring. The ethnographic data gathered has proved the link between the eucalyptus and the drying up of water sources. A number of springs which are now inactive in the area around Great Zimbabwe like Chivhaivhai and Nyewenyewe, close to Morgenster mission, are surrounded by eucalyptus. These springs are known to have been active until the introduction of this tree species.

**Figure 21: The area around the second entrance to the monument during the rainy season (Photo by author, January 2017).**

There are other areas which were known to have been wet in historic records but have since dried up. For example, the area around the monument's second gate entrance (Figure 21) was a wetland which rendered travelling from the monument to the then Sheppard's hotel a difficult task particularly during the rainy season.

Another area with evidence of water and marshy conditions is the area behind the Rondavels, a visitors' accommodation facility at Great Zimbabwe, where what is left are reeds which indicate that this was once a water source. The locals are of the opinion that the major challenge with water sources within the monuments is the obstruction of water sources by ongoing building constructions or deliberate closing of water sources such as the case with the Chisikana spring. Although it is evident that land-use changes had an impact on the landscape of Great Zimbabwe, there is also need to understand the demographical changes in the area as well as climatic changes.

### 4.4 Demography and Water Consumption in and around Great Zimbabwe

Ethnographic surveys were undertaken in and around Great Zimbabwe so as to get a picture of the current water use and to get an insight into the water situation during the Great Zimbabwe period. The study area was divided into three main clusters. The first cluster includes the Great Zimbabwe Monument, Great Zimbabwe Hotel and Nemanwa Growth Point. The second cluster is Morgenster Mission and the third includes villages which surround the monument area.

#### *4.4.1 Nemanwa Growth Point, Great Zimbabwe Hotel and Great Zimbabwe Monument*

The Nemanwa Growth Point is a business centre 2km west of Great Zimbabwe, making it the closest populated area to the site. Wekwete (1988) defines a Growth Point as settlement in either a rural or urban environment with a potential for economic and physical development. Thus, Nemanwa Growth Point is one of those settlements. Currently, the Nemanwa Growth Point has a population of approximately 4000 people. The Growth Point started with very few individuals, mainly those who were working for the Masvingo Rural District Council (MRDC), Great Zimbabwe Hotel and the Great Zimbabwe Monument. The Great Zimbabwe Monument and Hotel accommodate very few employees within their premises leaving the bulk of their employees having to travel from Nemanwa Growth Point to their workplaces. There are also a number of people who work in Masvingo town, Morgenster Mission and surrounding schools and clinics who stay in the Growth Point's residential areas.

#### *4.4.2 Morgenster Mission*

Morgenster Mission (30°55'42.31"E, 20°18'35.36"S) is about 5 km south of Great Zimbabwe. The mission was established in 1891 as the first Dutch station by Andrew Louw. It is a mission comprising a hospital, a school, a teachers' college and a university. The mission has an estimate of 2000 residents. The mission population fluctuates between 3000- 5000 people as a result of the services offered, like boarding and hospital facilities. Water for Morgenster is drawn from a nearby dam. Morgenster

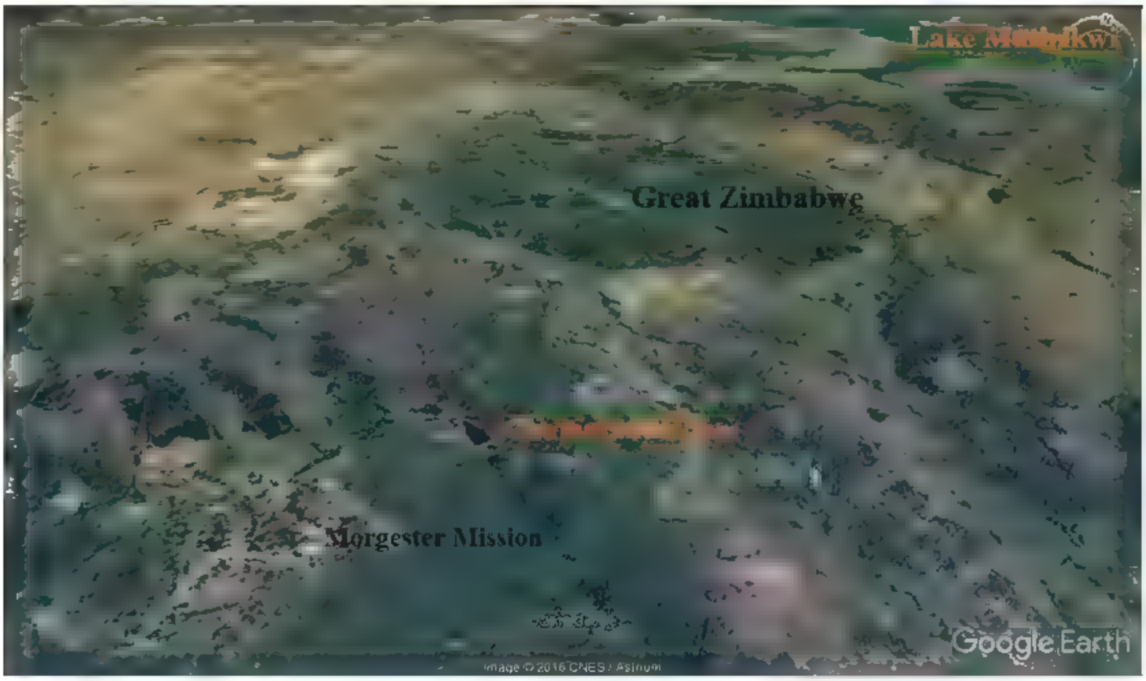



**Figure 22: Location of Chamatanda Dam which supplies water to Morgenster Mission (from Google Earth).**

Mission is one of the areas that have been occupied for some time by early European settlers. Fontein (2015) argues that water was a critical component in securing white settlement in Rhodesia's early days This is probably why Morgenster Mission is situated in a well-watered area. There used to be many sources of water at Morgenster with the whole mission characterised by swampy areas Areas which used to be swampy include the area now occupied by the theological college as well as the many areas which are characterised by water reeds, which grow in areas where the water table is high Great Zimbabwe and Morgenster Mission both share hilly locations as a characteristic feature but unlike Great Zimbabwe, Morgenster is located on a '*dinha*', a flat mountain top where agriculture is practised. The hill where Morgenster is situated is also characterised by underground tunnels (*ninga*) One of the informants highlighted that it was sometimes possible for the '*guti'* to persist for almost a month.

For Morgenster Mission, early water sources included a spring close to Morgenster Secondary School. Even before the arrival of the missionaries, some people were living in these areas, indicating that there was sufficient water In 2012, the Teachers' College drilled a borehole which has the capacity of supplying the entire mission. Water from this borehole was reached at a depth of close to 60m, which is an indicator of the scarcity of underground water Water for daily use is obtained from Chamatanda Dam north of the mission (Figure 22). Chamatanda represents the oldest source of water for the mission since at least 1911. Records indicate that water was fetched from there using animal drawn carts. This dam mainly gets its supplies from rainwater. The mission has since monopolised the dam as villagers are no longer allowed to use its water

At times, water for the Morgenster Mission is drawn from Munzviru dam which is to the south-west of the mission. A connection to Munzviru River was done after the 1992 drought, which saw most dams drying up. The Chamatanda and Munzviru dams are sufficient to supply Morgenster Mission. The cut in the provision of water at the mission is attributed to mechanical faults in the water pumps and pipes, and not necessarily water shortage Rev Nkomo highlighted that health and water are critical components and as such the mission works closely with the Environmental Management Agency (EMA) and have since hired a health technician who is responsible for water safety issues

During severe droughts like that experienced in 1992, the mission resorted to spring water, and the two springs which have never dried up are the Wayside spring, which is about 3km from the mission, as well as the one at the Morgenster Secondary School. Even though these two springs are perennial, the water output has decreased over the years and population increase is often cited as the reason behind the decreasing water yields from the springs

#### *4.4.3 Communal Areas*

The communal areas surrounding Great Zimbabwe include Boroma, Nemanwa, Mungwini, Mugabe, Mukungwa, Muzvimwe and Sikato as well as the newly resettled villages in Mzero farm (Figure 23). The villages in the study area have an estimate of 2000 people combined. These villages, including a growing population of people who recently occupied the Mzero Farm, mainly obtain their water from springs. Thus, most villagers rely on spring water with very minimal water engineering. The

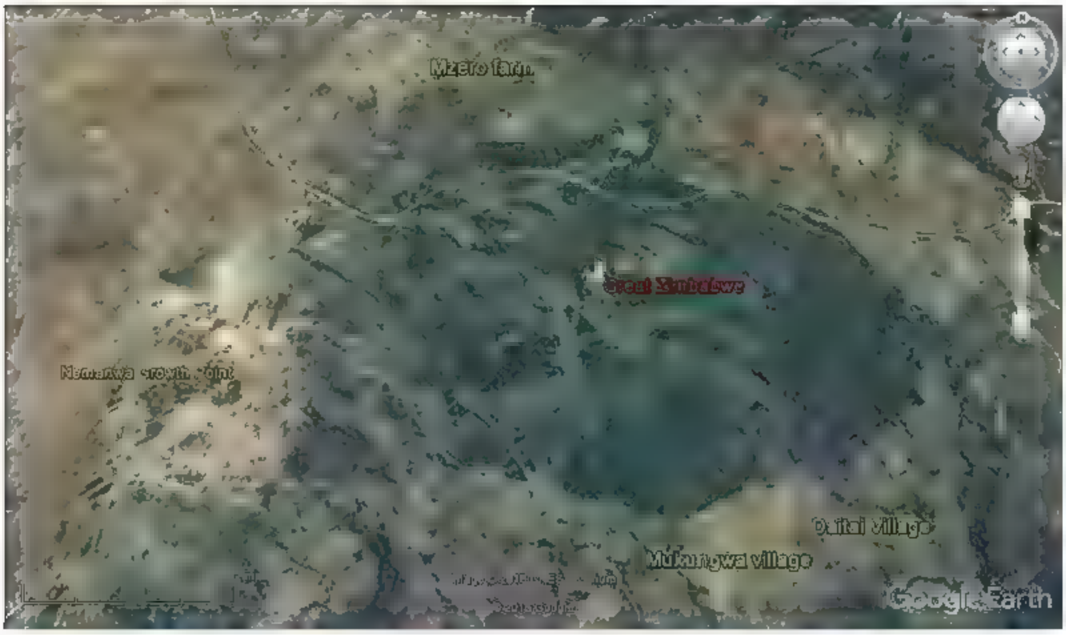



**Figure 23: Villages around Great Zimbabwe (modified from Google Earth).**

water for cooking, drinking and washing is obtained from springs. In villages like Daitai, some ephemeral springs are also used for livestock. A few villagers have dug wells and boreholes on their homesteads.

### 4.5 Water Management Systems

Great Zimbabwe falls under climatic conditions characterised by a short rainy season (October to March) and a long dry season. During the rest of the year, people rely on perennial rivers and underground water, which in most cases is in the form of springs, for domestic use, hence the need to document the water management and water engineering strategies. Mithen (2010) argues that there is need to consider prehistoric water engineering and water management systems in a bid to understand current water crisis and to find solutions for the same. The link between contemporary management strategies and the archaeological record is relevant at Great Zimbabwe since it is clear that the structures that form the core of the ancient city were built with water management strategies in mind. This is evidenced by the drain holes that are found in the Great Enclosure as well as the Balcony Enclosure in the Hill Complex (Figure 24-29). The drain holes as shown in Figure 24 are situated at the bottom of the wall, showing that the structure was predesigned. Figure 26 shows that besides the holes, the inside was paved, showing the ingenuous engineering skills in managing water.

The Great Enclosure has four (4) of these drain holes whilst there are 3 in the Balcony enclosure. Early visitors and explorers to the site such as Bent (1895), Hall and Neal (1904) and Mennell (1903) were able to identify these drain holes and argued that they were for purposes of draining water out of the enclosures. The drain holes show some advancement in building engineering techniques and recognition of the need to control water movement. Mennell (1903: 8) argues that the careful provision of dealing with flood water is 'sufficient to show that the builders had a considerable degree of civilisation'. Another example is Masey, an architect who was invited by the then Rhodesian administration to inspect and recommend conservation of the site in 1909, who observed that the entrances were furnished with steps to keep off flood water as well as 'drain holes next to the ground to get rid of water falling within' (Masey 1911: 44). Thus, it can be argued that water management strategies at Great Zimbabwe were not an afterthought but rather an integral part of the structural engineering of the monument. This is evidenced by the fact that these drain holes are actually found at the base of these gigantic structures which shows that they were not later additions. It can, therefore, be argued from this perspective that there has always been a way of managing water at Great Zimbabwe.

Apart from the drain holes, water management at Great Zimbabwe is also evidenced by terraces on the south western slopes of the Hill Complex. There are a number of these terraces. It is most likely that the residents of Great Zimbabwe devised ways of managing the slope from running water.

#### *4.5.1 Management of Drinking Water*

Domestic water, which has been taken to include water for animals, gardening and human consumption, is central to the study. The ethnographic data gathered point to different management strategies for different water uses. The purpose of the water therefore determines how the water is managed although there are some overlaps. Springs as well as open wells have been the main sources of drinking water at Great Zimbabwe and the surrounding areas. The springs occur naturally while the open wells are artificially made by digging up areas where the water table is high or

Figure 24: Drain hole 1 at the bottom of the Great Enclosure wall. Photo taken from the outside of enclosure (by author).

Figure 25: Drain hole 1. Photo taken from outside of the enclosure (by the author).

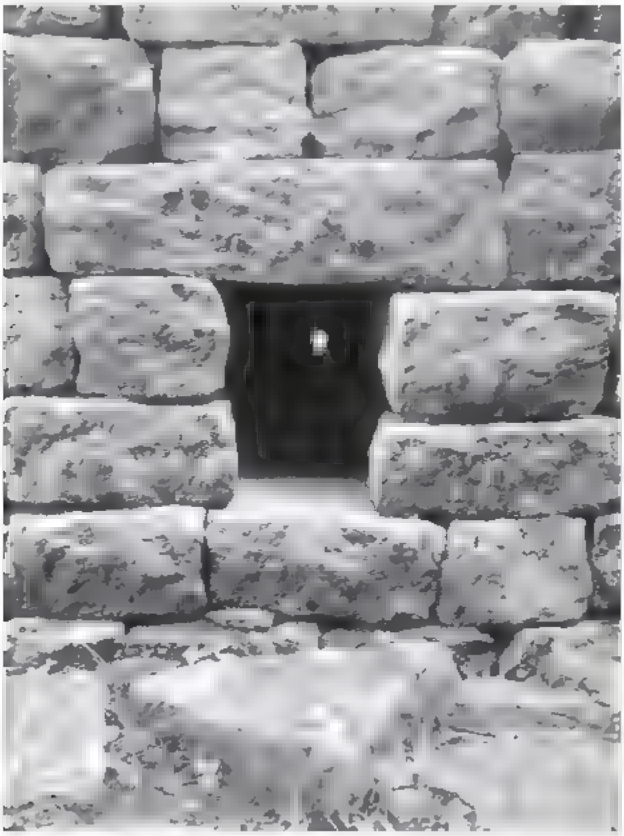


Figure 26: Drain hole 2 in the Great Enclosure (photo taken by the author from inside).

Figure 27: Drain hole 2 showing pavement in the Great Enclosure (photo taken from inside by author).

**Figure 28: Drain hole 5, view from the inside of the Balcony Enclosure of the Hill Complex (photo by the author).**

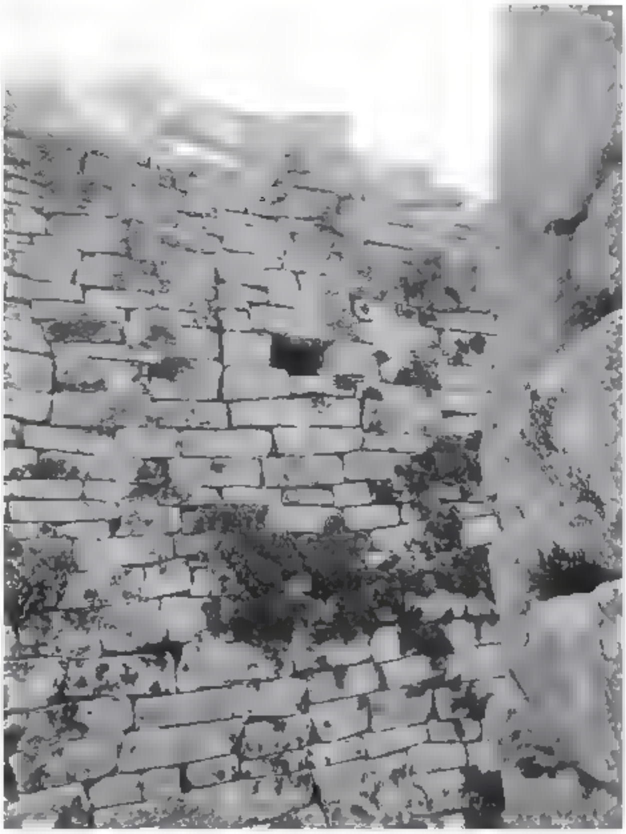


**Figure 29: Drain hole 5, view from the outside of the Balcony Enclosure of the Hill Complex (photo by the author).**

where there are zones of permanent saturation (Van der Kamp 1995; Todd and Mays 2005) From oral accounts, the number of active springs has decreased over the years and the story of the Chisikana spring is evidence of loss of once active springs In spite of having many springs, not all springs provided drinking water for the community Some of the springs were avoided as a result of the taste of the water.

One way of traditional management of (drinking) water has been through ritualisation Springs as well as the open wells are considered sacred and certain taboos are put in place so as to regulate how water is fetched from the source Examples of such taboos include avoiding the use of containers with soot to fetch water as this would invite the wrath of water spirits (mermaids), and the avoidance of the use of soap anywhere close to the water sources. Another example of such taboos includes forbidding fishing certain types of fish such as catfish and *siluriformes* (*mhatye*) that are found in springs. The fish is found in almost all the springs. There are stories of harvesting this fish in almost now extinct springs and water reservoirs, among them the '*dhaka* pits'. There are some sacred water sources where it is a taboo to use unapproved utensils or modify the spring A case is Burutsa spring (20°16'7.45"S, 30°54'27 28"E), some 200m west of Nemanwa Growth Point, where legend has it that a certain elder went there with a shovel with the intention of widening the mouth of the spring The shovel was pulled down until it disappeared, only to be found the next day thrown out. On the same spring, a certain lady went to fetch water with a pot, and the pot was sunk by an unknown force and never seen again. Even in contemporary times, these water taboos are revered by all people regardless of religion. The case of taboos as a management strategy is an indicator that society is regulated by appropriate ritual behaviour. Thus, taboos are valuable water management systems since they encourage sanitation by discouraging the use of dirty and unsuitable containers. Drawing from the ethnographic present, it can be argued that such traditional water management systems may have helped preserve water sources during the period when Great Zimbabwe was occupied.

There are also other elements which support the ritualisation of water and the brewing of beer rituals at the springs (*dororemanyukwa*). This is a ritual meant to appease water spirits so that the springs as well as rivers do not dry up. The ritual was conducted in a similar way as rainmaking ceremonies. However, whereas rainmaking ceremonies are done during the drier months of the year in preparation for the rainy season (Pwiti et al. 2007), the *dororemanyukwa* is done at the end of the rainy season. The ceremony is meant to ask God not to let rivers and springs go dry. The *doro remanyukwa* ritual is, however, now rare compared to rainmaking ceremonies.

Besides the taboos and ritualisation of water, there are also physical efforts in traditional management of water in the areas around Great Zimbabwe There is controlled access to drinking water sources. Barriers are put in place such

**Figure 30: Water Management strategies at Wayside spring along Morgenster road (photo by author).**

**Figure 31: a) use of stone b) use of logs   Physical barriers to the protection water sources– Wayside spring and a well in Mungwini village (photo by author, July 2014).**

that in most cases there is a single way which leads to a drinking water source. Irrespective of people coming from different directions, the drinking water source is usually approached using a single route. Physical barriers are sometimes put in place to protect the water source from animals. The physical barriers include logs or stones to lessen contamination (Figure 30 and 31) It is clear that the physical constructions are meant to protect water sources from damage by animals. Currently, villagers make sure that springs which are sources of drinking water are in thorn-fenced or wire-fenced gardens.

Figure 30 shows physical management of water resources The logs are put to cover the water sources so that both animals and human beings are not exposed to the danger of falling into them.

In terms of water allocation, water sources are considered a communal resource and regulations put in place should be adhered to when fetching the water The management of drinking water or water for household use is, however, different from that of water for domestic animals and for watering of crops. Drinking water is usually ferried by women using containers which they carry on their heads, scotch carts and in few instances by car from the source to homesteads. Minimal engineering skills have been invested in re-channelling water from its source to areas of utilisation. Lately, pipes are being used in some areas to supply a homestead (Figure 32 and 33)

**Figure 32: Pipes laid to draw water from Nyewenyewe for domestic purposes (photo by author, July 2015).**


**Figure 33: The now dry Nyewenyewe spring (photo by author, July 2015).**

**Figure 34: Natural water collection at Machakawa spring, south-west of Nemanwa Growth Point (photo by author, May 2015).**

In such cases, water engineering strategies have been blamed by traditional authorities for the drying up of the springs. A case is Nyewenyewe spring, near Morgenster Mission where there is evidence of overdrawing of the water. It is also probable that the eucalyptus plantation, a few metres upstream to the east, has also contributed to the drying up of Nyewenyewe spring. Although there is still some debate, researches seem to be supporting the argument that eucalyptus trees are 'thirsty trees' which draw a lot of water and contribute to the drying up of wetlands. Another factor that has contributed to the drying up of the spring is overdrawing of water by rapidly increasing populations.

Other water management strategies include fetching water with specific utensils like gourds (*dende/mukombe)*, an example being at Burutsa spring where such utensils have always been used. There is generally lack of physical management strategies particularly those which relate to the distribution of water. The rainfall at a particular time determines the quantities and quality of water. A case of Machakawa spring, one of the perennial springs in the vicinity of Great Zimbabwe, is an example of the minimal water management strategies (Figure 34). The increasing population puts pressure on water resources and as such, villagers have to devise strategies of dealing with the situation.

Most of the water sources are located downhill or in the valleys, thus making the most difficult part of the journey to fetch water being the return journey uphill. However, there are very few instances where the water source is at an elevated place such that ferrying water is a downhill task. An example is Chepfuko spring in Nemanwa village. Villagers have to walk uphill to fetch water from the spring.

### *4.5.2 Management of Water for Domestic Animals*

There is a tendency to forget that Great Zimbabwe was a city with a 'normal' way of life comprising domestic animals as well as crop fields. Thus, there is need to consider domestic animals in deliberating the hydrological processes at the ancient city. From ethnographic records, domestic animals, particularly cattle and goats, are a prominent feature in the study area. There are also water management strategies designed to cater for domestic animals. If the water sources are deep, strategies may include fencing to avoid drowning. During drier periods, the damming of streams is sometimes done so as to collect the little amounts of water remaining in the stream.

There are certain instances where there are natural pools which remain with water even when other parts of a river are dry. Ethnography points to the large pits found to the western edge of the Hill Complex as an example of such pools. Even though the informants could not ascertain whether these were human-made or natural, they were certain that at one point these 'pits' were water reservoirs. According to oral accounts, these pits used to have water for a long period of time after the stream had dried up. Example of pools that acted as water reservoirs were observed in Boroma, a village 3km east of Great Zimbabwe. Domestic animals would drink water from water collected in these pits during drier periods of the year (Figure 35).

Without proper and sustainable water management strategies, cattle and other domestic animals would endure long journeys to get water during drier periods. This was the case with the 2015/2016 season, characterised by a prolonged dry spell. It was observed that 'herdsmen are now driving their cattle for more than 10km to water

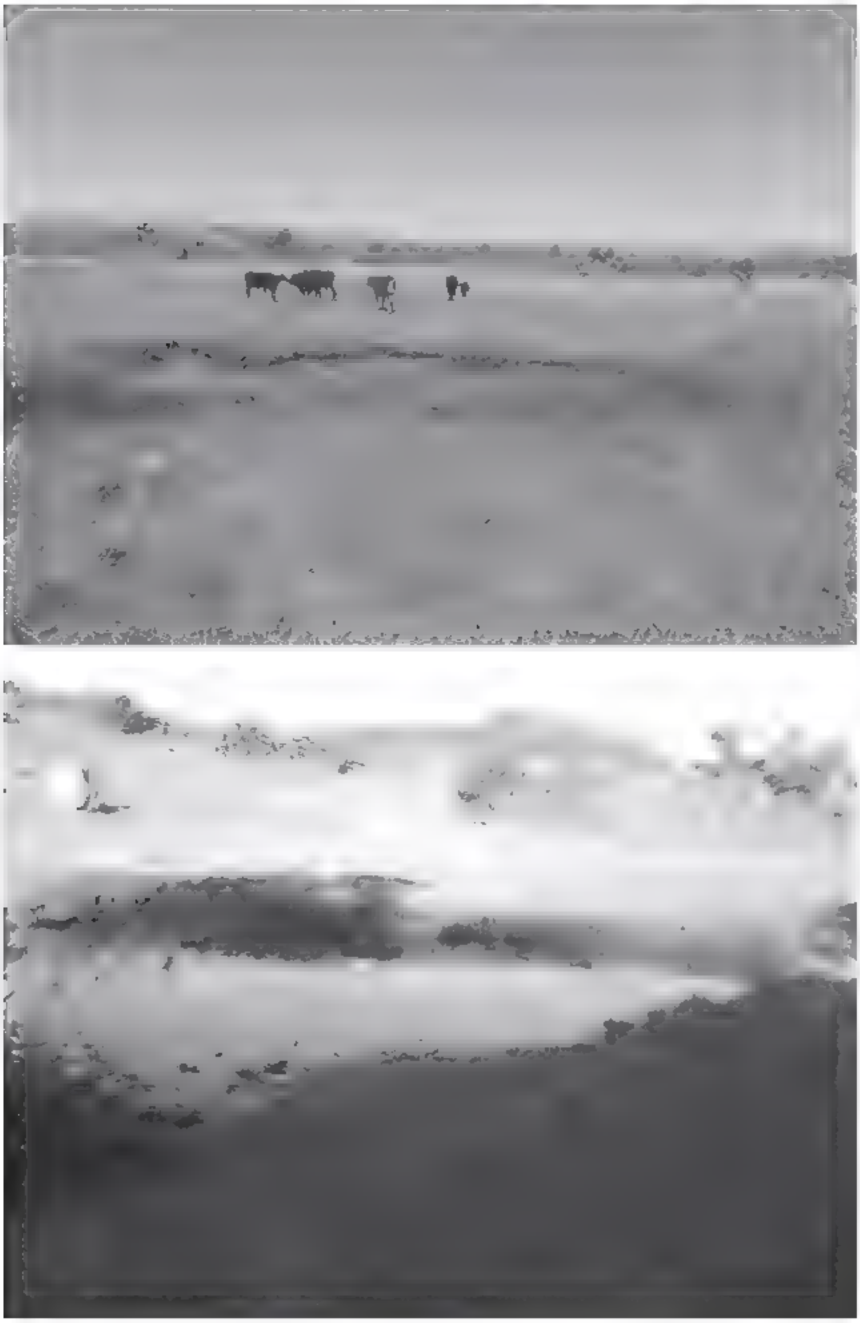


**Figure 35: Pools in dry streams in Boroma, south east of Great Zimbabwe (photos taken during winter season by author, June 2014).**

them in the lake (Mutirikwi) because all the small streams feeding the lake have dried up'.[1]

### *4.5.3 Water for Irrigation*

Rain-fed water plays a pivotal role in the cultivation of crops in the area around Great Zimbabwe. Crop cultivation is done mostly during the rainy season. The crops that are grown for subsistence include maize and millet, which all depend on the natural rainwater. However, during the drier season, people engage in gardening activities in the seasonal swamps referred to as *matoro/dambos*. Currently, the crops grown include vegetables, bananas and tubers such as sweet potatoes. Oral accounts indicate that some villagers used to grow *shezha* (*plectranthusesculentis*) in the swampy areas around Great Zimbabwe.[2] Thus, there is no diversion from Sinclair's (2010) observation that the *matoro dambos* may have helped to secure food provision especially during the dry seasons or during droughts.

The gardens used to be individually owned and recently, there has been an increase in community gardens. In a bid to curb hunger and encourage the sustainable use of water, a number of Non-Governmental Organisations (NGOs)

[1] *Financial Gazette*, 28 January 2016.

[2] Interview with Elder Makasva, 23 July 2015, Mzero Farm.

**Figure 36: Water furrows in Boroma, south east of Great Zimbabwe (photo by author, September 2015).**

such as CARE International, introduced communal gardens around Great Zimbabwe. The NGOs provide communities with inputs such as seeds and water pumping equipment as well as facilitating workshops to provide villagers with agricultural and market gardening skills. As the population increases so does the number of vegetable gardens with gardens upstream using the bulk of the water, leaving those downstream with far much less water.[3] Community gardens therefore came as a relief to villagers who were complaining about unfair water distribution.

Water for gardening is usually obtained from the rivers, streams and springs. It was observed that most people around Great Zimbabwe use containers to ferry water from the source to the fields.[4] In some instances, however, water is channelled to the fields or gardens through the use of furrows or canals (Figure 36).

The ethnographic record exhibits less effort in water engineering in the diversion of water for gardening purposes. In most cases, the gardens are situated in the swampy areas (wetlands). Hence, rather than re-directing water to the crops, efforts are usually channelled towards draining the swamps. Using evidence from early researchers at the site (Randall-McIver 1906, Hall and Neal 1904; Hall 1905a), which indicate a swampy Great Zimbabwe, it is probable that gardens were also located within the built area.

### 4.6 Conclusion

Using archival and ethnographic material, the chapter has identified the main sources of water in the study area highlighting the major rivers as well as springs. The information obtained is argued to be a window through which the situation that obtained during Great Zimbabwe's occupation can be deduced Notable is Chisikana spring which is dominant in the written records as well as in the oral narratives from the local communities. The landscape history in the study area, with particular focus on the built-up area, has been analysed noting that a number of changes have taken place in the last century and these had both direct and indirect impacts on the waterscape of Great Zimbabwe. Chief among them has been the use of cement in the physical sealing of the Chisikana spring as well as the construction of amenities. This probably caused the drying up of most of the water sources around Great Zimbabwe. An insight into the sustainability of the water has been gained through the analysis of demography in the area with particular focus on how people are copying with the ever increasing demand of the water resources. The chapter has also analysed the various water management strategies used by the local communities It can be argued that sources for drinking water were and continue to be managed through the use of taboos with minimal physical infrastructure to protect the resource Community livelihoods depend on rain-fed agriculture, and in addition people also engage in various gardening activities such as irrigation in the drier months The main type of irrigation is the bucket irrigation although other forms like the use of canals have been observed in the area. Water for domestic animals is rarely domesticated as the animals get their water from rivers, streams and springs in the area Thus generally, the communities around Great Zimbabwe depend on rain-fed water as well as underground water in the form of springs. Although it should be acknowledged that the ethnographic present cannot be taken to represent what obtained in the pre-colonial past, it is possible to draw inferences from contemporary water sources and water management systems among communities around Great Zimbabwe to understand what may have obtained during

3 Interview with Elder Mayaya, 15 July 2015, Muzvimwe Village

4 Field observations, 15 July 2015

the period when Great Zimbabwe was occupied. Archival sources and historical documents produced by literate observers who either visited or managed Great Zimbabwe in the late 19th century and early 20th century reveal how water was a major challenge at this ancient city. Historical photographs are also crucial in unravelling the changes in the landscape and the general vista of the Great Zimbabwe in the past one hundred years. The following chapter analyses the hydrology of Great Zimbabwe and how this could have influenced the spatial patterning exhibited at the site

# 5

# Hydrology of Great Zimbabwe and its Archaeological Implications

## 5.1 Introduction

While the previous chapter (4) examined the ethnographic and historical accounts concerning water, water sources and water management at Great Zimbabwe, this chapter mainly focuses on hydrology and its archaeological implications. It makes use of GIS tools to compute design flow on the site and uses drainage and basin analysis to examine surface water and its implication on the built environment at Great Zimbabwe. The chapter discusses the underground water potential with a particular focus on groundwater recharge into wells and springs. This is followed by a precipitation and runoff analysis of the landscape Ultimately, water management strategies are obtained from analysing the interaction of the various components in the hydrological cycle. Adaptation strategies are deduced from the hydrological models. The study acknowledges that there are other means through which water is lost such as evapotranspiration, ground infiltration as well as human use. The chapter also deploys watershed analysis, and watershed boundaries are used to assess water availability. The computation of design flow is achieved using conceptual as well as empirical methods (Wheater 2002; Uhlenbrook et al . 1999; Nayak et al 2013). Hydrological modelling is done with a particular focus on run off which helps in providing an insight into how the natural water channels could have impacted on the choice of settlement location as well as explaining some of the features found at the Great Zimbabwe site Hydrological modelling and analysis was done using the ESRI ArcGIS programme (see chapter 3 on methodology).

## 5.2 Hydrology Components

The general setting is critical in understanding the hydrology of an area. To understand water and to develop its management strategies, it is critical to also understand water in its various forms (Winter et al. 1998) The hydrological cycle involves the storage of water in water bodies and its transmission through the biosphere, atmosphere, lithosphere and the hydrosphere (Zhao and Li 2015). The different processes of the hydrological cycle are related such that change in any of the components is likely to affect other processes. Change in precipitation, for example, has a bearing on the amount of water that is discharged into streams and rivers. The saturation of the soil determines the amount of water that infiltrates the land as well as surface runoff Soil type is a key variable in determining water flow (Compagnucci et al. 2001). This is mainly due to the fact that derived characteristics of soils such as geology types, vegetation cover, artificial drainage systems, water and land use management systems have a bearing on water flow. In view of the foregoing, to fully conceptualise watersheds, it becomes necessary to also review availability of existing environmental data on variables such as precipitation and vegetation which in turn affect evapotranspiration as well as groundwater.

### *5.2.1 Precipitation*

Precipitation plays a critical role in water balance over space and time, making it the main variable in the process (Compagnucci et al. 2001; Pilgrim et al. 1988, Hughes 2007). The availability and variability of water resources in an area are determined by, among other factors, the precipitation patterns. Precipitation's role in a catchment includes replenishing of aquifers (Pavelic et al. 2012). This means that effective rainfall determines recharge and it has been observed that in arid and semi-arid regions, river flows are very sensitive to changes in rainfall. This makes precipitation the main component of a catchment input.

The Zimbabwe escarpment, falling within the southern African region, experiences highly seasonal rainfall between October and May (Jury 1996; Makarau and Jury 1997). The region is also characterised by recurrent droughts (Rouault and Richard 2005, Milgroom and Giller 2013). The escarpment receives convective rainfall that is characterised by short duration, high intensities and large spatial heterogeneity, which is typical of arid and semi-arid regions (Pilgrim et al. 1988). However, the Southern African region suffers lack of continuous records of rainfall and other hydro-meteorological variables such as stream flow (Hughes 2007). Consequently, scholars have to draw on the general data of a country or province to understand the hydrology of specific areas.

Great Zimbabwe and its immediate landscape is characterised by drizzle (*guti*) which is a result of the orographic effect generated by southeast winds (Bannerman 1982). The *guti* sustains micro-climatic conditions which prevail around Great Zimbabwe even during times of poor rainfall or drought, it provides essential moisture for cultivation of crops. Great Zimbabwe and its surrounding areas are unique in that in addition to the convective type of rainfall, they also enjoy downpours and moisture brought in by *guti*. This is well-illustrated by differences in the vegetation between Great Zimbabwe and its immediate surroundings and areas below the escarpment (Bannerman 1982; Chikumbirike 2014; Pikirayi et al. 2016). Bannerman (1982) observed that *guti* conditions

bring in considerable rains around Great Zimbabwe. These result in contrasting in moisture regimes between Great Zimbabwe and Nyanda Mountain further west, which lies in the rain shadow. The *guti* is orographic in nature, creating a rain shadow some 30km west of Great Zimbabwe. For Bannerman (1982), the escarpment looks like a well-watered island surrounded by comparatively drier land. The limiting factor to proper farming engagements within the Great Zimbabwe and its surroundings today is land governance, where activities such as farming and cutting of firewood are prohibited, otherwise precipitation as well as the topography are more than adequate for agricultural engagements. A more detailed examination of the area immediately around Great Zimbabwe shows that despite the domination of the geology by granite, almost all areas are suitable and arable, except for the *dambos*/marshes. The few metamorphic rocks mainly north of Great Zimbabwe produce fertile soils making agriculture viable around the site (Garlake 1978). The soils within the core of Great Zimbabwe are thus composed of mainly dark brown silty loam soils. The other soil type, which is less common, consists of reddish brown clayey loam, observed mostly on lower slopes.

Rainfall readings from two weather stations (Great Zimbabwe and Masvingo town) were obtained from the Zimbabwe Meteorological Office so as to gain an insight into rainfall patterns for the area. In the case of Great Zimbabwe, the available rainfall data covers the period between 1987 and 2002. Rainfall recordings for the period between 2003 and 2011 are however incomplete. In the absence of nearby stations, which could help in estimating missing precipitation data at Great Zimbabwe, analysis was done using the data from the Great Zimbabwe station. Most of the methods that are used in estimating missing data involve interpolation based on readings from nearby stations. As a result, the years with no records of rainfall available were not included in the analysis. The rainfall pattern for the period 1987—2001 is shown in Figure 37.

With an average rainfall of 338.6mm for the period 1987-2001, the data show that the precipitation in the form of rainfall received in the study area was capable of providing enough water to account for runoff as well as river discharge.

The trend shows that rainfall has been increasing over the 15 year-period. This is supported by the trendline equation of ‘y=33.86x+327.4’. A positive gradient is an indication that there is increase in the rainfall over the years. Although the trend indicates a rise in the precipitation over the years, yearly readings against the mean show a considerable variability. For example, out of the 15 year-period, only 5 of the years received above average rainfall whereas the rest were below average. This was validated using the variability test. Coefficient of Variation (CV) is defined as the ‘the degree of precision to which the treatments are compared and is a good index of the reliability of the experiment’ (Gomez and Gomez, 1984). A normal variable for climate data is 30% and below. Variability has to be lower than the 30% for it to be dependable (Nyatuame et al. 2014).

The formula is:

Coefficient of Variation (CV) (standard deviation Mean) x 100

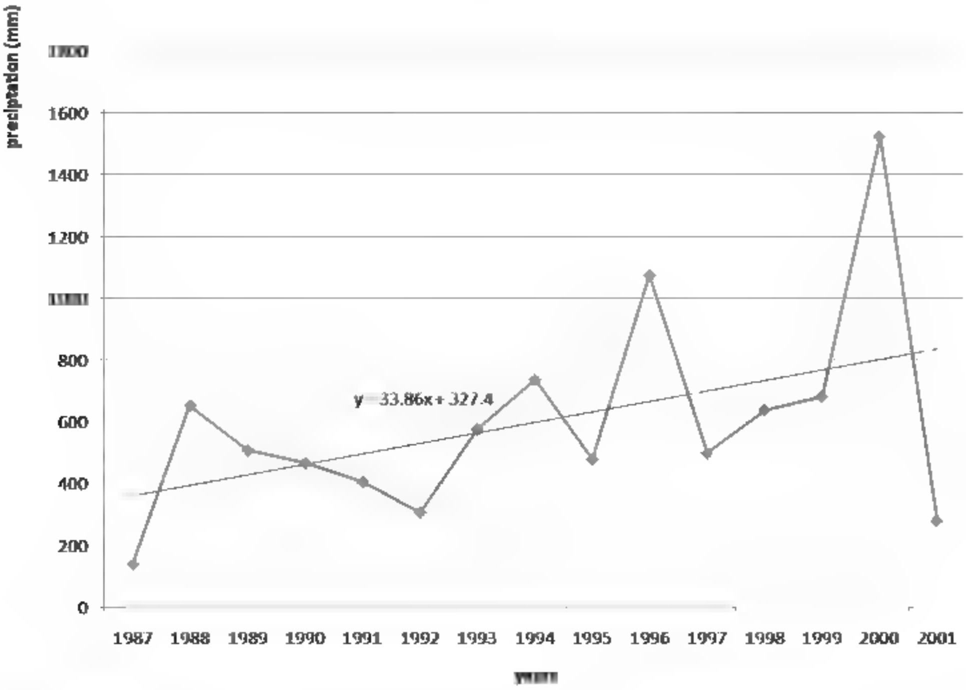



**Figure 37: Annual rainfall totals for Great Zimbabwe covering a 15-year period (1987-2001) [data supplied by the Meteorological Department, Harare].**

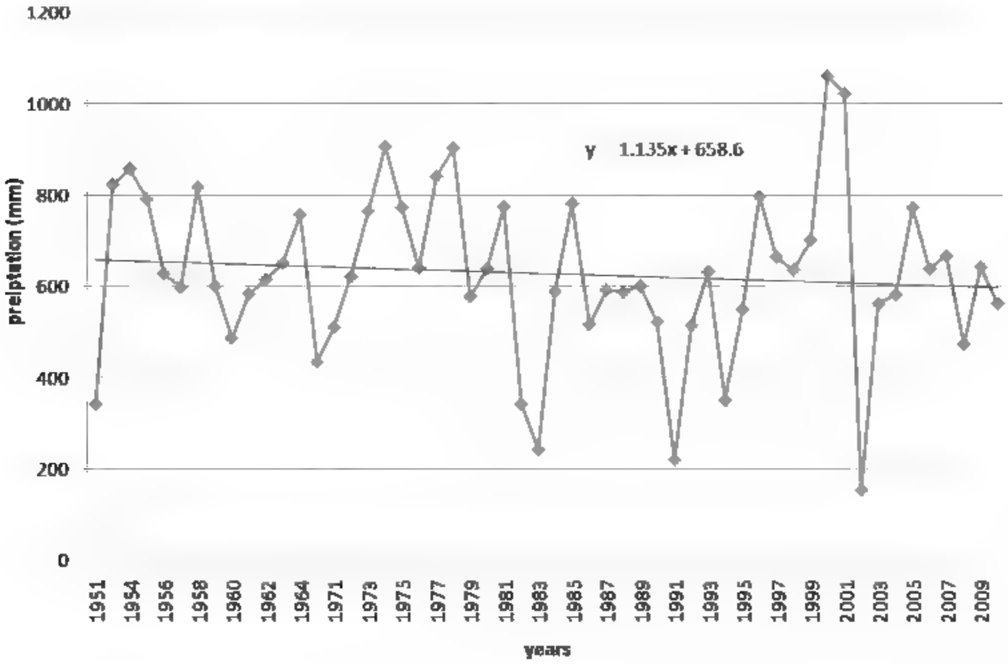



**Figure 38: The trendline for the rainfall data at Masvingo station for the period 1951 - 2010 (data supplied by the Meteorological Department, Harare).**

Thus for the Great Zimbabwe rainfall data,

$$CV = (338.5895/598.34) \times 100$$
$$= 56.588\%$$

This makes the data highly variable, statistically. Thus, a variability of 56.6 % confirms great inconsistency. The high value of the coefficient variation implies that in as much as deducing that rainfall has been increasing over the period can be done, it has to be done with caution due to high variability. The few years that receive above average rainfall can be explained by the La Nina effect which causes cyclones, thus rendering the data unreliable.

Rainfall data obtained from Masvingo weather station covering the period between 1951 and 2010 was used to compare trends in climate variability (Figure 38). In comparison to the available rainfall data for Great Zimbabwe, Masvingo weather station has more data with rainfall records covering almost 60 years. The use of Masvingo rainfall data is meant to review the general trend in climate variability within the broader region.

There is a variation between rainfall data obtained from the Masvingo weather station and that from Great Zimbabwe weather station. Whereas data from Great Zimbabwe shows an increase in rainfall, data from the Masvingo weather station shows a general decline. The trendline equation shows a negative gradient indicating that generally, rainfall is on the decrease. The difference in the trends at Great Zimbabwe can be attributed to the differences in the amount of data. For Great Zimbabwe, available data is for a period of 15 years whereas for Masvingo, the rainfall data is for a period of more than half a century. Inspite of the difference in the rainfall data, the Great Zimbabwe micro-climate cannot be ruled out as a possible factor in the variations in trends between Great Zimbabwe and Masvingo. To assess the reliability of the data, the coefficient of variation was performed on the data using the formula,

$$CV = (\text{standard deviation}/\text{Mean}) \times 100$$
$$= (184.1/627.5) \times 100$$
$$= 29.3\%$$

The coefficient variation value of 29.3% falls within the normal variation for climate data, an indicator that statistically there is not much variation in the data. Therefore, conclusions can be made with some level of confidence on the trends that have been identified. Basing on the fact that rainfall data from Masvingo weather station covers a longer period, it can be used to also interpret the patterns at Great Zimbabwe. If Masvingo rainfall data is taken in to also represent Great Zimbabwe rainfall patterns, the trend that emerges is that of a decrease in annual average rainfall over the last 60 years. This, however, needs not discount the possibility of the impact of microclimate on rainfall patterns especially given the fact that the Great Zimbabwe environment is characterised by drizzle and orographic rainfall (*guti*).

The average rainfall for the 15 year period at Great Zimbabwe is 627.5mm. This amount of rainfall can have significant impact on the runoff processes in the area. The amount of rain, coupled with the nature of the terrain where much of the land has an average percentage slope rise of 9% (Figure 39), makes run-off an inevitable process.

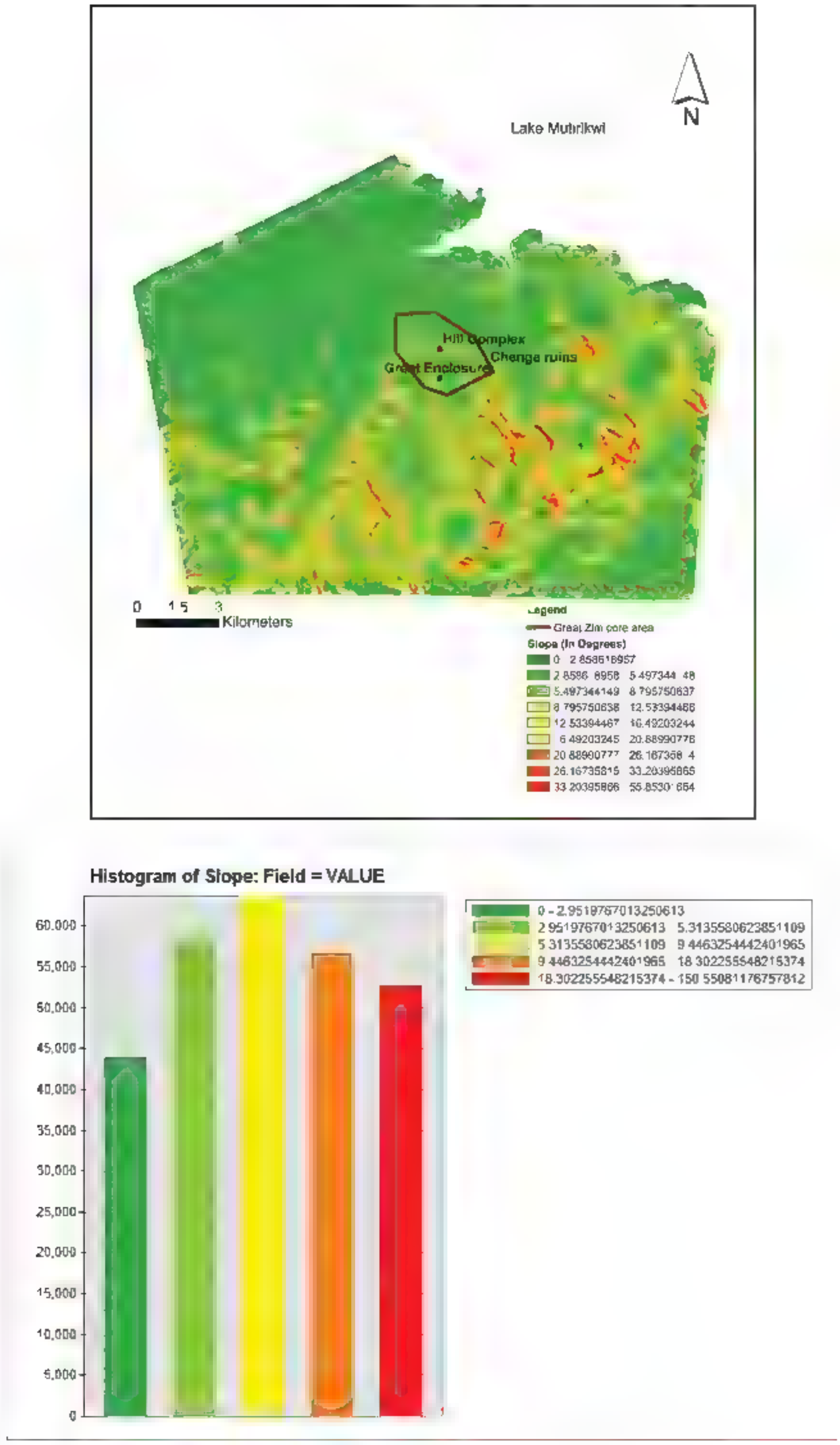



**Figure 39: Slope map and histogram for the study area in percentage rise.**

The slope map shows changes in elevation expressed as percentage rise. This shows the steepness of the Great Zimbabwe landscape. Besides slope being a factor in determining the amount of surface run off, it also accounts for the amount of soil loss from the catchment The complex nature of the hydrologic cycle renders the assumption of having all precipitation flowing downhill as too simplistic The underlying geology of an area can make understanding of surface runoff complicated Some geological formations make it possible to have groundwater flowing into another catchment area other than what may seem obvious (Davie 2002). Thus, the permeability of the underlying geology is one of those factors that affect surface runoff Other variables that affect surface run off are evapotranspiration The evaporation of water, whether intercepted by vegetation or from water bodies, is affected by prevailing temperatures (Brooks et al 2012) Raghunath (2006: 61) argues for a direct correlation, noting that 'the higher the temperature and wind velocity, [the] greater the evaporation' Temperature

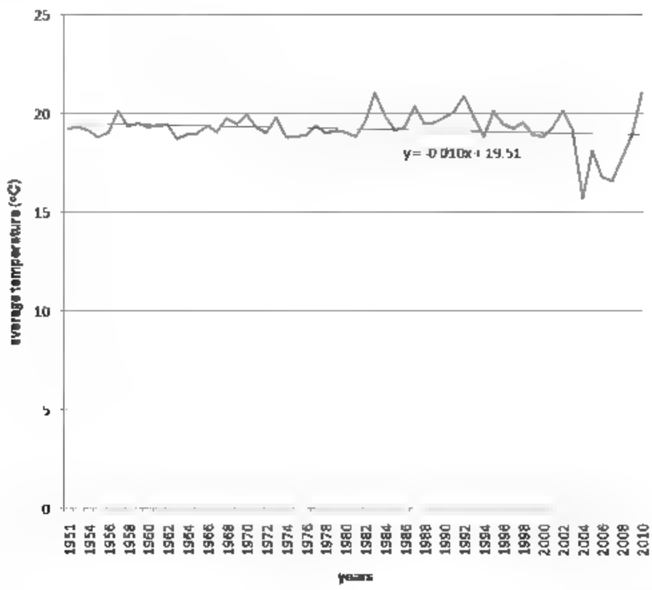



**Figure 40: Average daily temperatures recorded at Masvingo Airport weather station (source, Meteorology Department).**

data was thus analysed to assess trends and likely effects on the hydrology of the area. Temperature data from Great Zimbabwe weather station was not available and in its absence, data from Masvingo weather station was used to see trends in temperature changes over the years. The temperature data from Masvingo weather station covers the period between 1951 and 2010. Trends in temperature are shown below (Figure 40).

The average daily temperatures for the period 1951-2010 show a general trend of decreasing temperatures. The data shows less variability with a coefficient of variation of 4.7%. The recorded data does not vary greatly from the average. There are only a few instances where some years record a sudden drop and increase in the atmospheric temperature. The average daily temperature is 19.2 °C.

The effects of temperature on evapotranspiration cannot be overemphasised. Some scholars have argued that in as much as there are several factors that affect streamflow, the recent trend has been to focus on the effects of climate change on streamflow (Jones et al. 2012). In a number of cases, increasing temperatures have been a key factor affecting streamflow. It is against this background that temperature readings were taken from Masvingo Airport weather station, some 30km north-northwest of Great Zimbabwe. In terms of temperatures, there is no great spatial variation between Great Zimbabwe area and Masvingo town. Consequently, in the absence of temperature readings from Great Zimbabwe, readings from Masvingo Airport weather station were used as a proxy in examining Great Zimbabwe temperatures and their impact on the hydrology.

***5.2. 2 Vegetation***

Evapotranspiration is also affected by the vegetation in an area. This makes data on vegetation important in hydrological modelling as it is related to evapotranspiration, a key component of the hydrological cycle. Evapotranspiration is the least known component of the hydrological cycle (Maneta et al. 2008). Therefore, an analysis of the vegetation is a proxy for evapotranspiration data. Great Zimbabwe vegetation is characterised by the *Brachystegia/Julberardia* or *miombo* woodland (Bannerman 1982; Chikumbirike 2014; Pikirayi et al 2016). Areas characterised by *miombo* have been associated with the presence of wetlands (*dambos)* (Pikirayi et al 2016). *Dambos* are defined as low lying, gently sloping and treeless lands which are seasonally waterlogged by seepage from surrounding high ground, some containing natural drainage channels for the removal of excess water (Bullock 1992; Scoones 1997). In these *dambos*, soil is richer than the surrounding areas due to the accumulation of organic matter and soil nutrients (Scoones 1991).

Species such as *Uapakakirkiana* (*mushuku*), fig (*Ficuscapensis*) and olive tree (*Olea africana*), which are known to survive in well-watered environments, are also found at Great Zimbabwe and its surroundings. Bannerman (1982) also points to patches of broadleaved montane-forest, which, he argues, could have been more extensive. This is one of the species that signify the presence of water. The presence of extensive grassland has also been observed. Bannerman (1982) observes that both sourveld, sweetveld as well as mixed veld are found in large areas within Great Zimbabwe and its surroundings, and that makes it the only part of the escarpment with such an environmental phenomena. The sourveld is found at Great Zimbabwe and stretches eastwards towards Bikita, including much of the country classified as middleveld below the escarpment; the sweetveld on the other hand lies in dry country to the south-west and west, starting within 10 kilometers of Great Zimbabwe (Bannerman 1982: 26). There is a marked climate change in a distance that is little more than two hours' walk such as in the valleys to

the western end of the Bikita escarpment. From Nyanda Mountain running along the northern extreme of the Beza Mountain range, extending eastwards, is a belt of acacia savannah, classified as sweetveld (Bannerman 1982: 25) In this regard, evapotranspiration around Great Zimbabwe can be higher.

### *5.2.3 Groundwater at Great Zimbabwe*

Hydrological studies require an understanding of both surface and underground water. According to Thomas (1952), the science of hydrology would be relatively simple if water was unable to penetrate below the earth's surface. The nature of groundwater is vital to the understanding of the hydrology of the area and, by extension, how residents of Great Zimbabwe made use of available water sources Groundwater constitutes more than 95% of the global, unfrozen freshwater reserves (Kresic 2009). Understanding the underlying geology helps in understanding the hydrological features around the site. Thus, an appreciation of the geology of Great Zimbabwe helps in understanding the hydrology of the area, especially groundwater

Great Zimbabwe is located on the Zimbabwe escarpment that falls within the African crystalline Basement Complex (Key 1992; Titus et al 2009). It is known to contain some of the oldest known fragments of the Earth's Precambrian crust, consisting of folded volcano-sedimentary successions of greenstone belts, the associated extensive gneisses and granites (3 5–2 6 Ga) and the Great Dyke (2 46 Ga) (Ranganai et al. 2008) These granites, paragneisses and sandstones support medium to fine sandy soils, which alternate with silty and clayey loams associated with basic igneous rocks, greenstones and dolerites (Sinclair 1987: 40). Sometimes, we are made to believe that groundwater occurs only in underground rivers and veins There are, however, numerous openings that exist between the grains of sand and silt, between particles of clay or even fractures in granite. Masvingo geology is characterised by mineral-bearing rocks of sedimentary and volcanic origin and Great Zimbabwe in particular is characterised by a belt of intrusive granites (Heath 1987).

Although granite is not permeable, water goes through cracks until it finds its way out to the surface as springs or into river channels. These geological formations give rise to springs A spring is defined as a location at the land surface where groundwater discharges from an aquifer, creating a visible flow (Kresic 2007) Predominant granites and important aquifers give rise to a characteristic landscape of granite and granodiorite hills and micro-catchments (Titus et al. 2009). Geologically, extinct springs can be a result of large scale groundwater withdrawals. The disappearance of springs as a result of large scale groundwater withdrawal has been observed as a common feature in arid and semi-arid regions. Water quality and quantity are also affected by unsustainable land-use. Thus, it can be argued that almost every human activity has the potential to affect groundwater (Peters and Meybeck 2000; Elhatip et al. 2003). Groundwater possibly holds the key to the mitigation of the impacts of climate change if managed properly and one of the reasons for the argument is that groundwater requires a smaller capital investment than surface water development (Pavelic and Rao 2012). Groundwater and surface water are viewed as linked components of the hydrologic cycle and as such, changes in one of them are likely to have an effect on the other (Sophocleous 2002).

The heterogeneous geological setting such as that found at Great Zimbabwe creates distinct baseflow regimes which in turn create the wetlands known as *dambos (vleis)* that characterise the area. The extensive distribution of these wetlands makes them hydrologically and agriculturally significant (Bullock 1992, Whitlow 1983). *Dambos* being a fundamental element in traditional farming and biodiversity, are utilised by contemporary communities around Great Zimbabwe for agricultural purposes (Figure 41). This is in tandem with Matiza's (1992: 100) observation that most gardens in communal lands of Zimbabwe are located in *dambos*.

Figure 41 shows the utilisation of one of the *dambos* within the Great Zimbabwe environment. This *dambo* is located about 500m west of Great Zimbabwe. Its major source of soil moisture is Burutsa, a spring which is in the area distinguished by tall green grass in the centre of the photograph. Even during droughts, the spring has never dried in living history. Villagers take advantage of the continuous soil moisture to plant vegetables as shown in the background.

The underlying geology has a great influence on the occurrence of *dambos* (von der Heyden 2004: 546). In the case of Zimbabwean *dambos*, they mainly occur on granites and gneisses of the African crystalline Basement Complex (Whitlow 1983; von der Heyden 2004) Processes in the catchment such as infiltration rate, amount of rainfall, surface run-off and location have a bearing on the hydrology within a *dambo* (Mharapara et al. 1998) The *dambos* found in the environs of Great Zimbabwe are mainly derived from granites, which provide more fertile minerals than those found in dolerite-derived *dambos* Most wetlands associated with the Basement Complex have two water tables: perched and temporary, deep and permanent.

The complex nature of underground water is fuelled by the idea that sometimes we are made to believe that groundwater occurs only in underground rivers and veins whereas in actual fact there are myriad openings that exist between the grains of sand and silt, between particles of clay or even fractures in granite (Heath 1983). Solids and voids make up the most of the rocks near the earth's surface and it is these voids that supply water to springs and wells. This complex underground is exhibited through streamflow loss and generation within the Great Zimbabwe area. It is in this context that Hughes (2007) argues that the need to understand these processes and scenarios increases

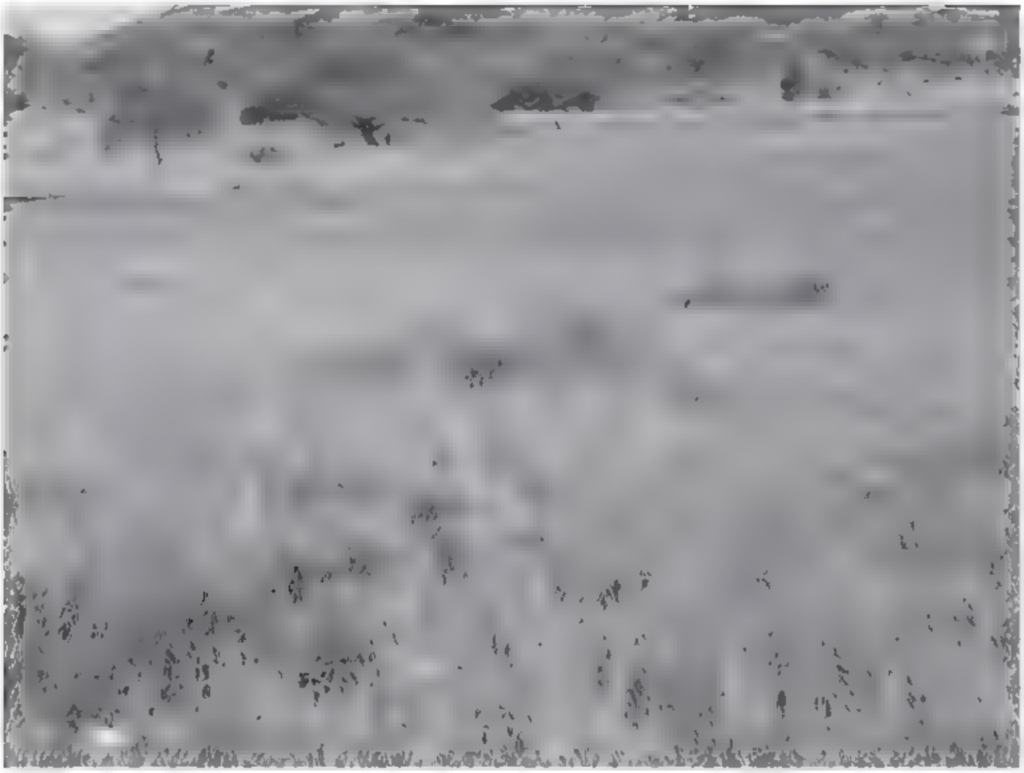


**Figure 41: Burutsa spring, marked by the green grass and a garden on a wetland 500m from Nemanwa Growth Point (photo by author, June 2015).**

the complexity of any modelling study. Generally, crytalline rocks such as granites are not permeable, and groundwater occurs mainly in the weathered and creviced zones (Ayenew et al. 2012). Fractures and regolith can contain aquifers.

Many headwater catchments in the communal lands of Zimbabwe are underlain by crystalline basement and groundwater flow follows the topography, sloping towards streams and catchment outlets (Macdonald and Edmunds 2014). Groundwater recharge is highly dependent on the occurrence of intense rainfall events and local management practices such as maintaining contour bunds to hold up runoff, which also promotes recharge. This is particularly vital as it has been estimated that evaporation greatly exceeds rainfall in the region, threatening groundwater supply (Davies and Burgess 2013).

### 5.3 Great Zimbabwe Watershed Hydrology and Catchment Response: Modelling Rainfall Runoff

This section assesses the behaviour of surface flow and examines the relationship between the channels of surface run off and the features such as the *dhaka* pits as well as the built structures at Great Zimbabwe. Surface run-off is just one component of the hydrological processes. This is because there are other processes that take place to the water that reaches the earth's surface. Data on drainage at regional scale has become readily available and free from a number of websites. The main watershed, the Mutirikwi catchment, including several micro-catchments, is drained by streams flowing towards the Mutirikwi River, a tributary of the Runde River, which eventually joins the Indian Ocean-bound Save River (Figure 42).

The surface runoff analysis was done in ESRI GIS programme with Terrain analysis using Digital Elevation Model (TauDEM), an adds-on software used for hydrological modelling. The TauDEM enabled the automation of watershed delineation as well as the hydrological modelling. This helped the process of understanding water management. In this context, TauDEM was used to analyse surface run off at the ancient city of Great Zimbabwe. Run-off models can also be used to predict stream flow. According to Rippon and Wyness (1994), such hydrological models are important in determining 'hypothetical' flows and other water sources in the past landscape and exploring the limits of their water supply. Curie et al. (2007) elaborated the significance of the use of watersheds based on topography arguing that it is the main factor that determines water pathways

#### *5.3.1 Stream Flow Characterisation and Statistics*

*Flow Direction*

Topography is the predominant factor that affects surface runoff. The golden rule in hydrology is that water flows downhill under the force of gravity. However, there are few instances when water flows up, for example, in the case of capillary action in the soil and evapotranspiration. Flow direction for the study area was conducted using the D8 flow direction algorithm and the basic outlook is shown in Figure 43 The D8 flow direction is a routing method for

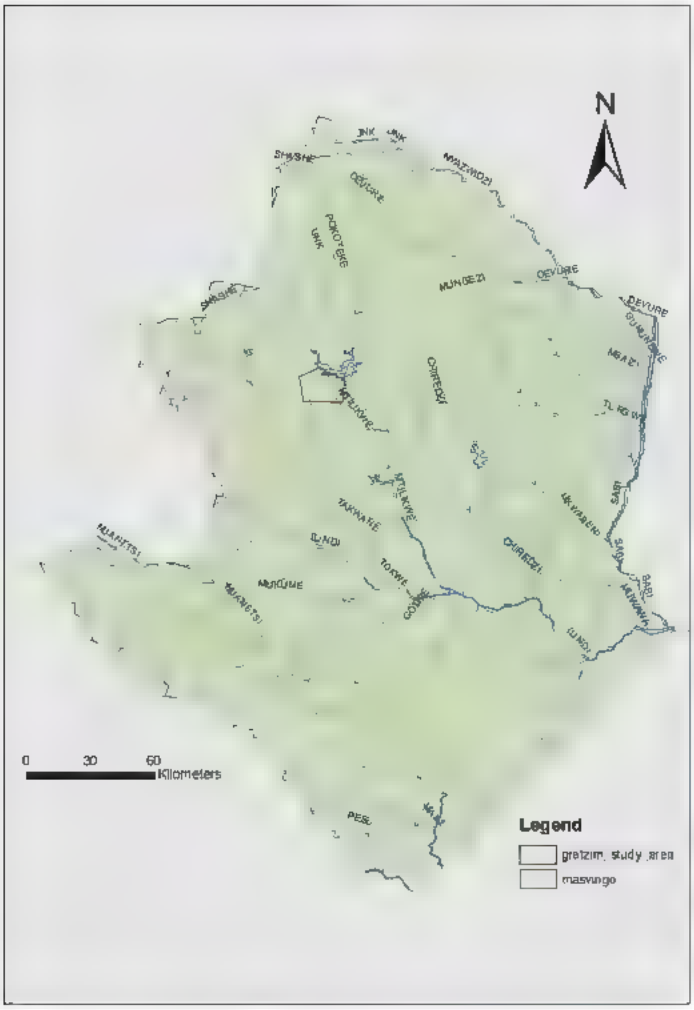



**Figure 42: Drainage of south-eastern Zimbabwe (modified from website, mapcruzin.com).**

flow direction. It provides a measure of relative position in the landscape within the context of simulated hydrological flow of surface water. In the D8 flow direction, each cell is connected to one of its eight neighboring cells following the direction of steepest descent. The D8 flow direction algorithm in TauDEM calculates the single steepest flow direction. Thus the direction of flow is encoded 1 up to 8 as follows

1- East
2- North-East
3- North
4- North-West
5- West
6- South-West
7- South
8- South-East

The flow direction map shows that most of the rain drops that fall on the Great Zimbabwe landscape flow to the east denoted by 1 on the histogram. Ground truthing confirmed this scenario where most slopes in the Great Zimbabwe landsape generally face an easterly direction. The generated histogram of the D8 flow direction concurrs with the aspect map, which also indicates that the east facing slopes have the highest number of cells in that category (Figure 44).

The aspect map (Figure 44) indicates that the south-west direction (class 6) has the least number of cells. This indicates that very few slopes face the south-west direction. The flow direction is regarded as the simplest model of direction where water would flow over a terrain and form the basis for the D8 contributing area. This makes it a key step in watershed delineation, where errors in the flow direction would affect the watersheds in that once a direction of flow is distorted, it would mean ending in a wrong basin. Thus, inaccuracies at this stage 'will propagate to the following stages and increase uncertainty in the final model results' (Svoray 2004: 259). However, most errors emanate from the Digital Elevation Model (DEM). Incorrect DEM is usually from those that are produced through interpolation of contours. In the study, the DEM was acquired from satellite imagery hence the reduction of risk in the production of the flow direction. The flow is thus forced into one of the eight cells surrounding the central cell. Flow direction therefore is determined by the slope and aspect as well as the surface shape which in turn determines water behaviour. The negative values on the aspect map indicate the flat surfaces in the landscape

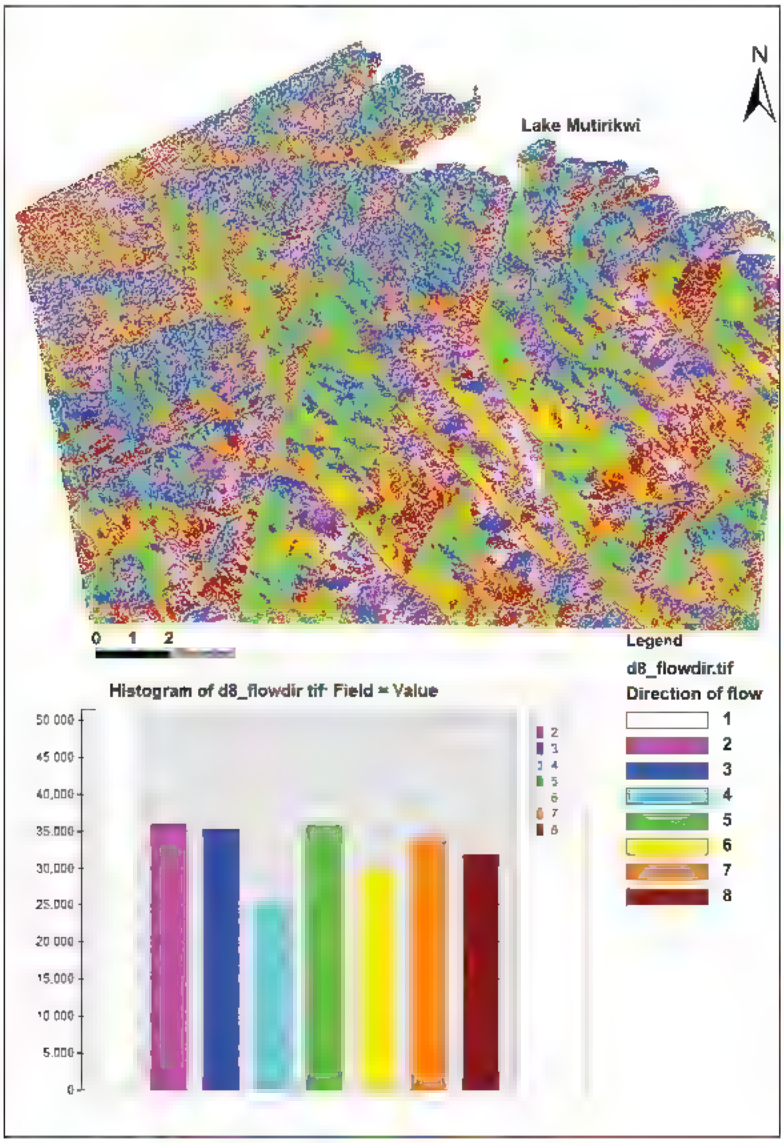



**Figure 43: D8 flow direction and histogram of Great Zimbabwe and its surroundings.**

Inference of drainage areas, flow lengths and delineation of watershed are made possible through the flow direction function.

*Flow Accumulation*

Flow accumulation is the second stage in the watershed delineation process. This process highly depends on the flow direction (Schäuble et al. 2008). Flow accumulation refers to the concentration of flow for every cell in an area, where each cell is coded with the number of upstream cells that drain through it (Connolly and Lake 2006, 432). High values are found in drainage channels whereas lower values are on hillsides and ridges (Figure 45). Using different thresholds, the channel networks are ordered with class 1 being the highest flow accumulation.

The stream order can be used to determine if a stream is perennial or ephemeral. Less flow accumulation areas are usually gulleys which are intermittent (only having water after a storm) and ephemeral (having water only for a part of the year) streams (McDonough et al. 2011; Hansen 2001). The data shows high spatial heterogeneity in the character of streams and rivers in the composition of the Great Zimbabwe catchment. Streams were derived from flow accumulation where the threshold to define a stream was set at 5000. Thus, for a water flow to be regarded as a stream it should be draining at least 5000 cells of the DEM. The result resembles the vector stream network (Figure 46). The Great Zimbabwe area consists of channels classified between 5 and 8, which are mostly intermittent streams. These streams are drained into surrounding streams and rivers. The Great Zimbabwe area is characterised by low flow accumulation values. From the simulated channel networks, no water naturally accumulates in the Great Zimbabwe area. From the modelling, these features can only be ‘artificial’ in nature. This makes the dambos and marshes found at Great Zimbabwe a result of people trying to control and manage water. A case in point is the area west of the Hill Complex which is likely to have developed

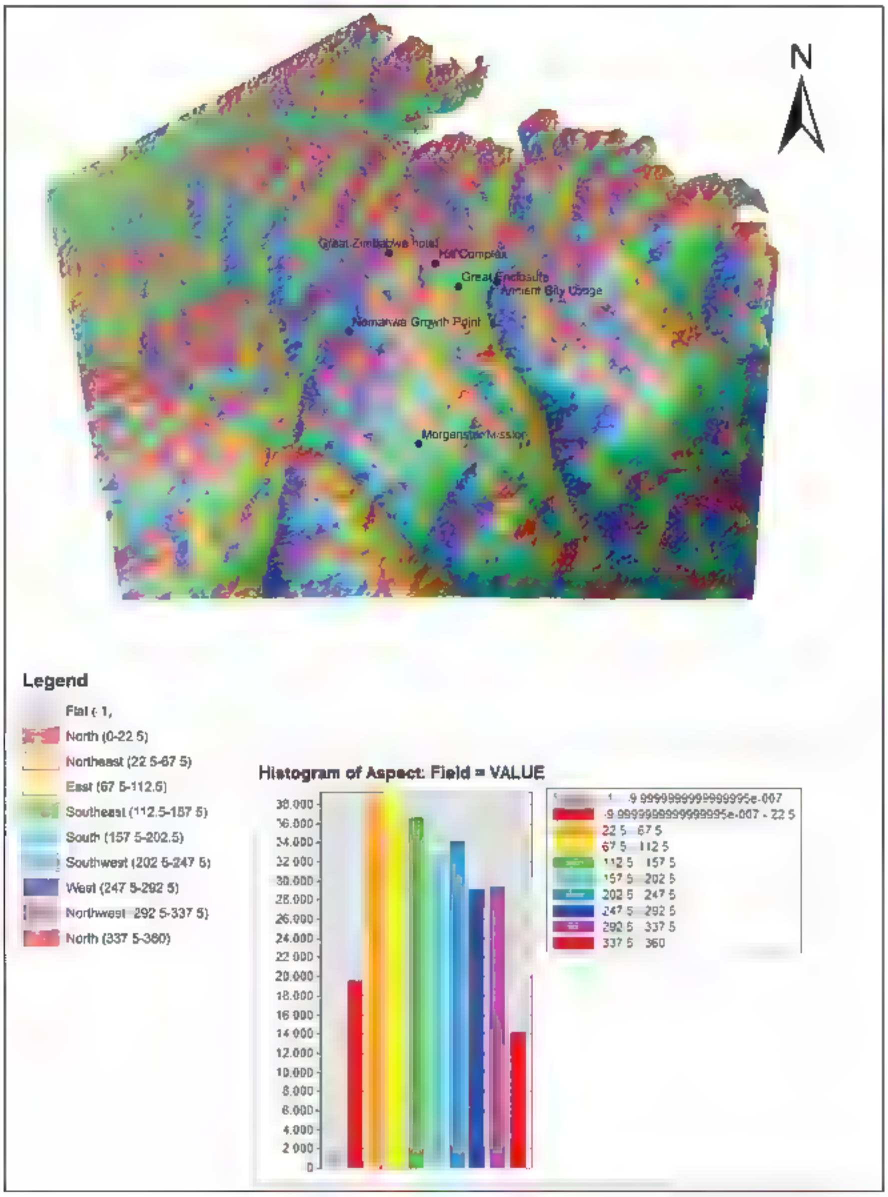



**Figure 44: Aspect map of the study area.**

as a result of people trying to control and manage water from the Chisikana spring. The nature of these streams determines sustainable water management strategies if the area relies on surface water.

Figure 46 shows several streams with several tributaries emanating from around Great Zimbabwe. The thin lines show less dense cell accumulation whereas the bolder ones are an indicator of denser cell accumulation. Where there is much denser concentration, these follow river channels. The less dense ones are largely tributaries of these rivers. Using an empirical threshold value, channel networks are delineated from the flow accumulation. The slightly higher values correspond to the main streams and rivers. Within the core of Great Zimbabwe, these are Mapudzi stream as well as Chisikana stream (Figure 47). These streams are an important part of the water at Great Zimbabwe. It is probable that the residents during the Great Zimbabwe period could have also obtained their water from these streams.

### *5.3.2 Delineation of Watersheds at Great Zimbabwe*

The delineation of watersheds was mainly done using topography as the major variable. The basis for delineations of catchment and sub-catchments is that they are the most common spatial units in studying hydrology (Davie 2002: 5). The catchment is sometimes referred to as the river basin which defines the land from which precipitation flows towards a river (Davie 2002: 5). These catchments are divided by watersheds which are defined as the natural division lines along the highest points in an area. To get an overview of the watershed at a broader scale, the Mutirikwi catchment with its sub-watersheds was delineated (Figure 48).

The watersheds for the Great Zimbabwe area and its surroundings were delineated (Figure 49 and 50). The watersheds were delineated using pour points, which are generally areas of high flow accumulation. In essence,

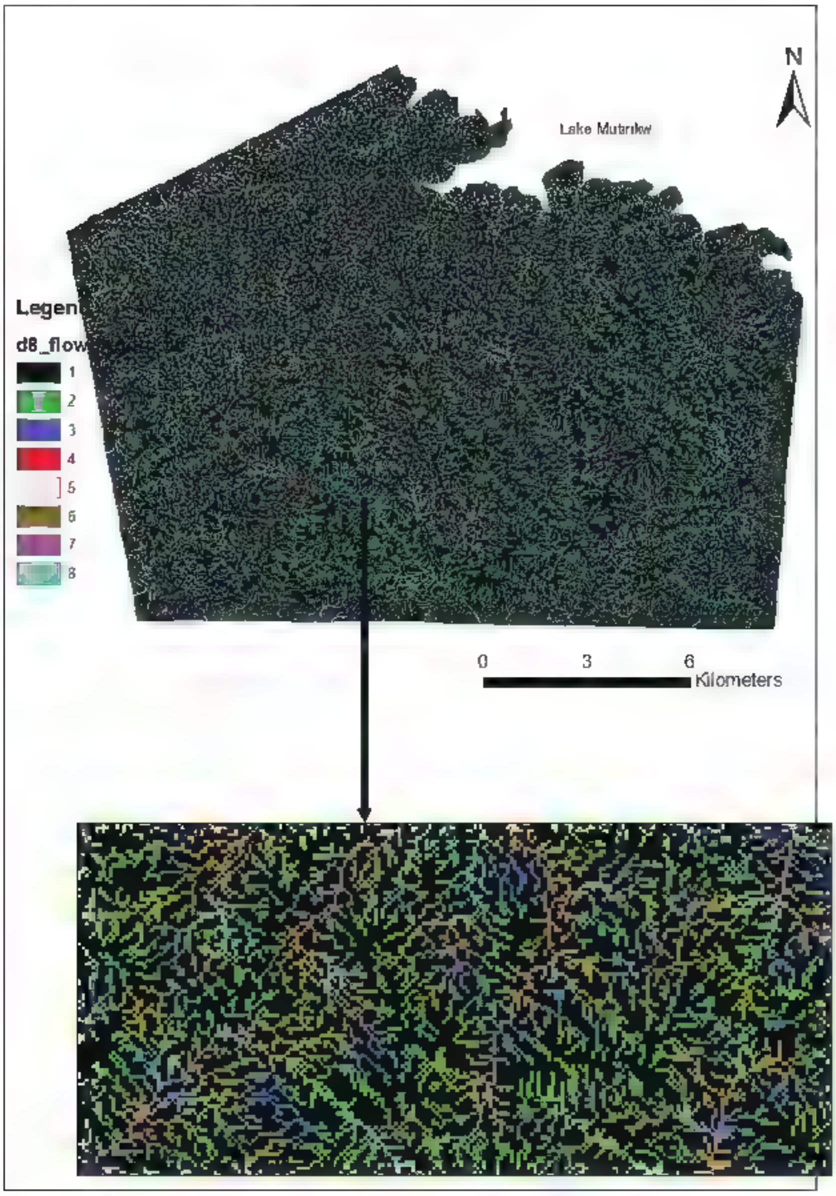



**Figure 45: Flow accumulation.**

they are outlets where all cells of a particular threshold flow

Figure 50 shows generated sub-watershed in the Great Zimbabwe area. Sub-watersheds were created by lowering the threshold of the drainage area. There are different sizes of catchments and sub catchments that characterise the Great Zimbabwe landscape. The various sizes of the sub-watersheds are determined by the amount of cells that pertain to drainage in a given basin. Surface runoff for the core of Great Zimbabwe has 4 micro-catchments. Of the 4, two are bigger and these are to the south-east into the Mapudzi stream and the northern watershed into the Chisikana stream. Chisikana stream is one of the ephemeral streams which is also characterised by streamflow loss upstream, only to appear downstream close to the ZINWA substation. The watersheds created are divided by hills and ridges forming several watersheds. There are two main rivers that drain the study area as well as the core of Great Zimbabwe. These are Mushagashe River (now covered by Lake Mutirikwi) and Munzviru River Both drain into the Mutirikwi River

### *5.3.3 Channel Networks and the Archaeology*

This section mainly examines the relationship between stream/river channel networks and the structures as well as the *dhaka* pits at Great Zimbabwe

*Dhaka Pits*

Although archaeologists have largely focused their analytical lenses on Great Zimbabwe's stone walls, there are a number of archaeological features on Great Zimbabwe's landscape that require archaeological analysis. Some of these features include *dhaka* floors and pits. In this section, I examine the archaeological implications of the *dhaka* pits located on the Great Zimbabwe landscape A total of

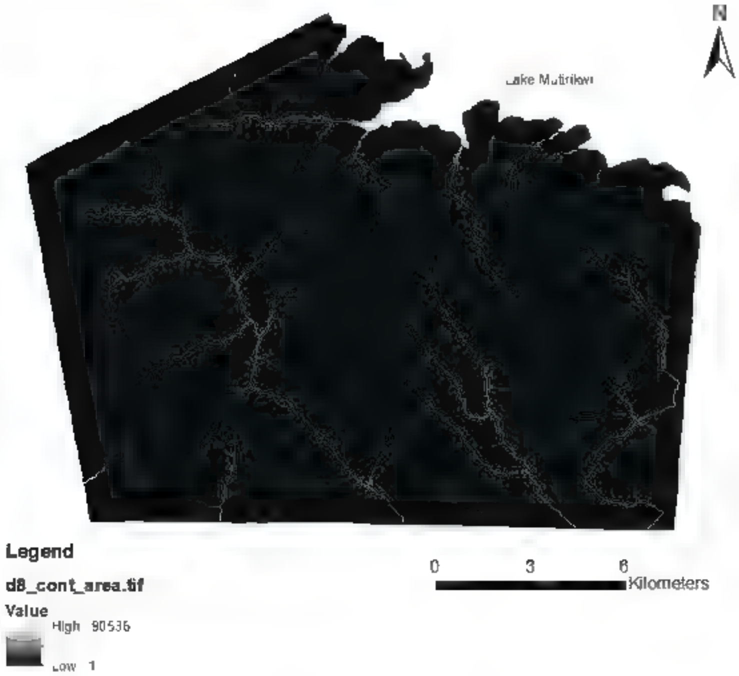



**Figure 46: Accumulation flow with threshold.**

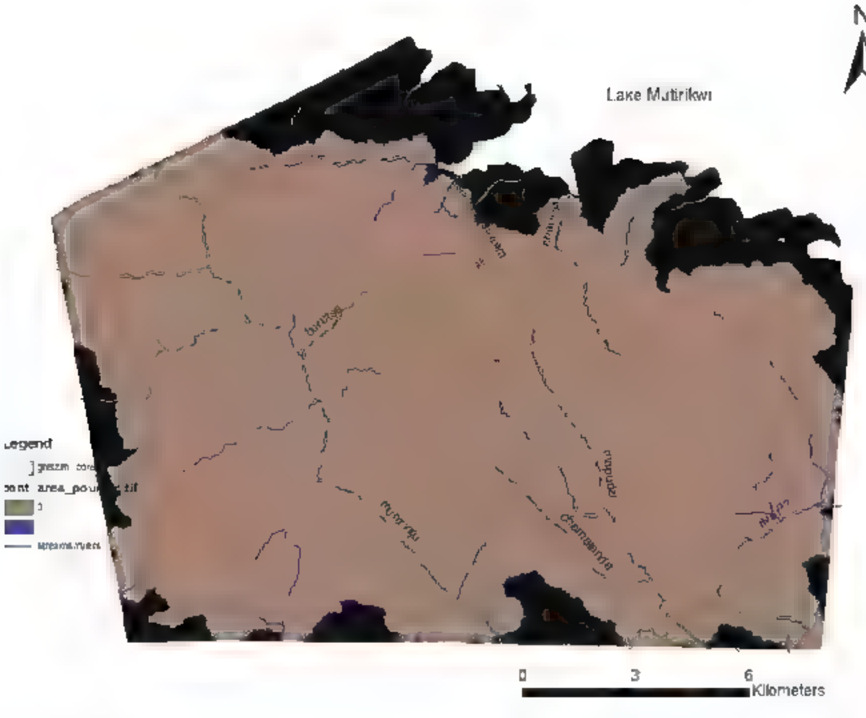



**Figure 47: Simulated water channels against the existing stream networks.**

seventeen (17) *dhaka* pits of different sizes were recorded during fieldwork For the purposes of analysis, these *dhaka* pits were identified by numbers 1 to 17 (Figure 51).

Pit 1

Pit 1 (20° 16' 10.2"S, 30° 16' 58.6"E) is located on the southern bottom of the Hill Complex. The pit is surrounded by a thicket of trees, but inside, there is only grass. Besides having grass, the top soil is dark in colour (Figure 52).

Among the trees that are within the vicinity of the pit is *Heteropyxis*, a genus which includes three species of small evergreen trees which are found along streams. There is also the presence of acacia which signifies the presence of water. Thus, the pit can be associated with the storage of water. The presence of tree species which are associated with riverine areas made Chikumbirike (2014) to argue that the environment was once wet A test pit measuring 70 cm deep was dug at this *dhaka* pit Soil samples were obtained for further analysis. Preliminary analysis from

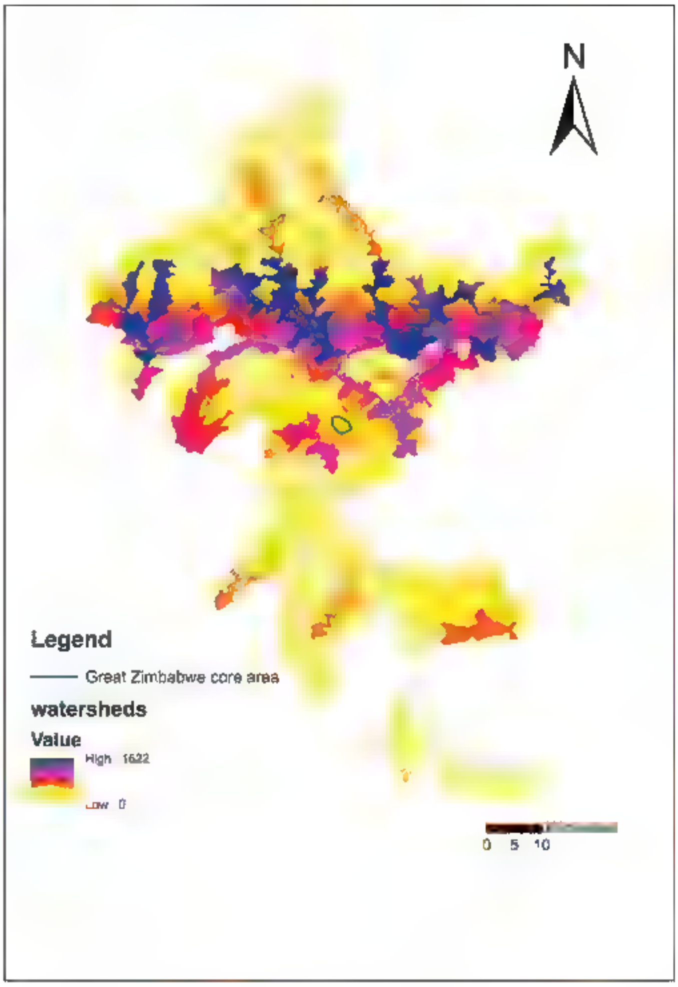



**Figure 48: Automated watersheds delineated for south central Zimbabwe showing sub-catchments of Mutirikwi and Mushagashe Rivers.**

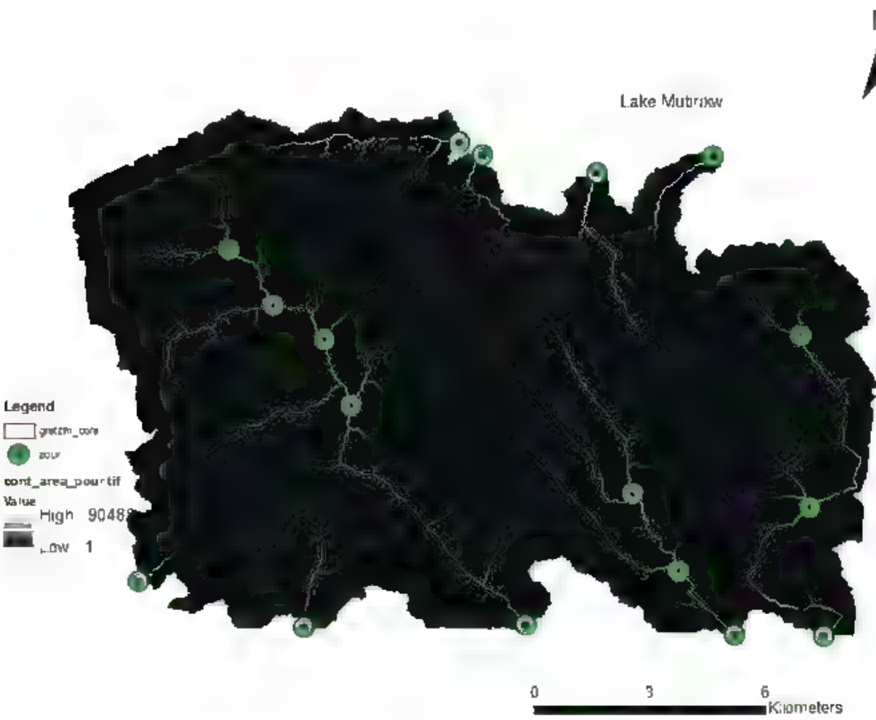



**Figure 49: Flow accumulation and pour points for the delineation of watersheds.**

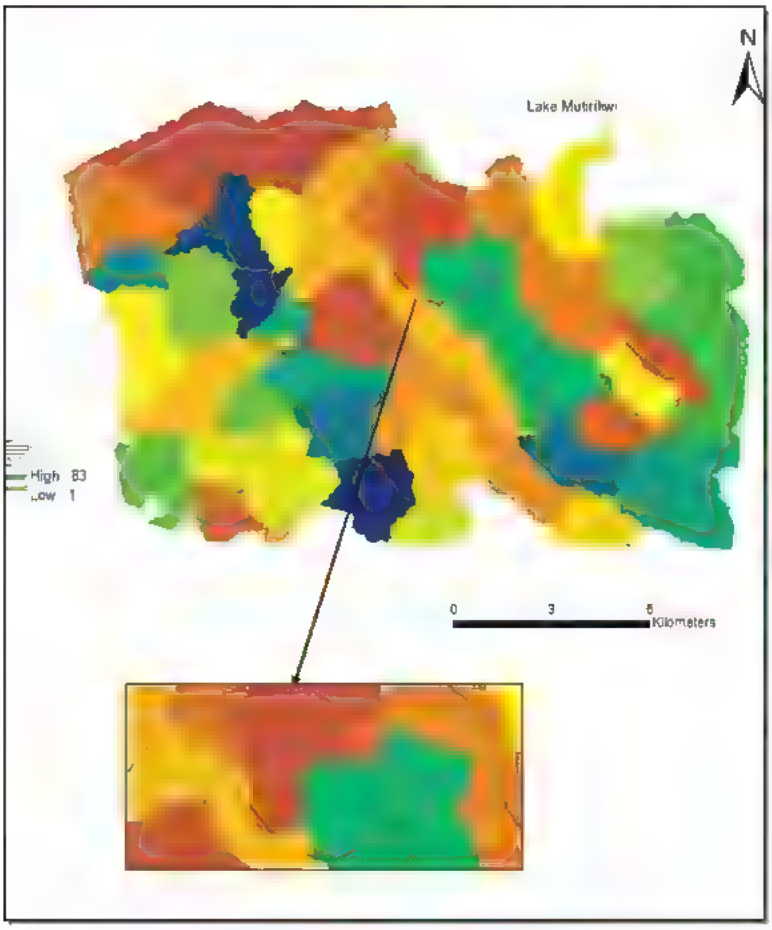



**Figure 50: Sub-catchments created for Great Zimbabwe and its surrounding areas.**

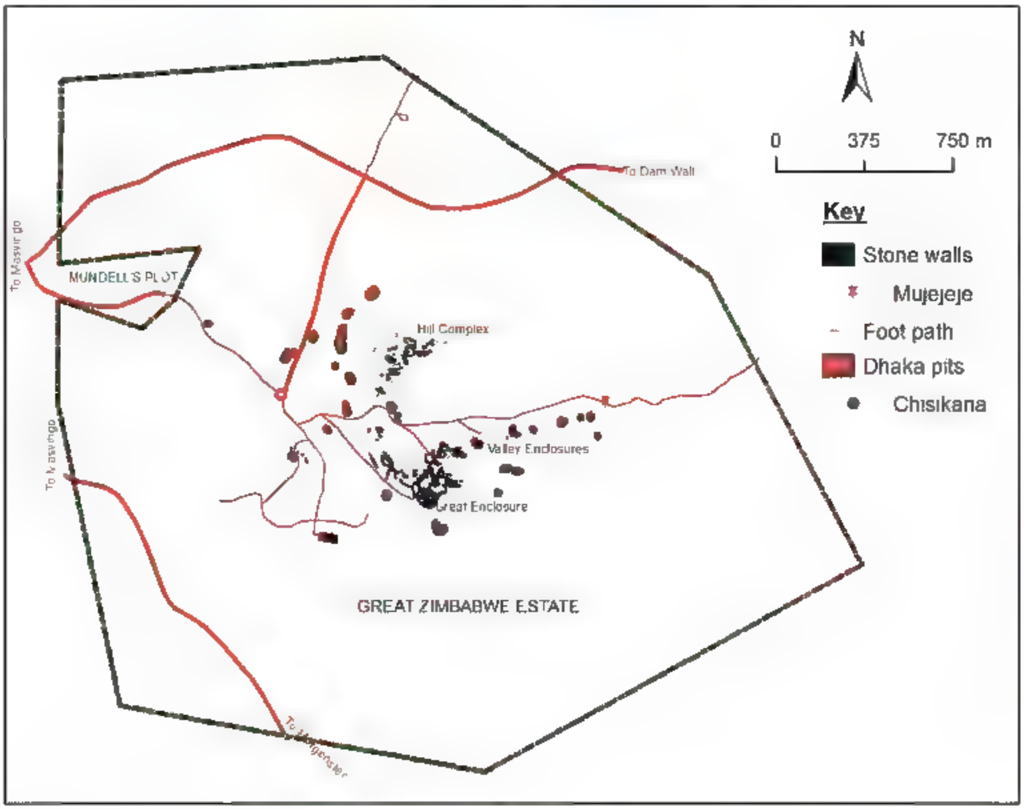



**Figure 51: Location of Pits within the core of Great Zimbabwe.**

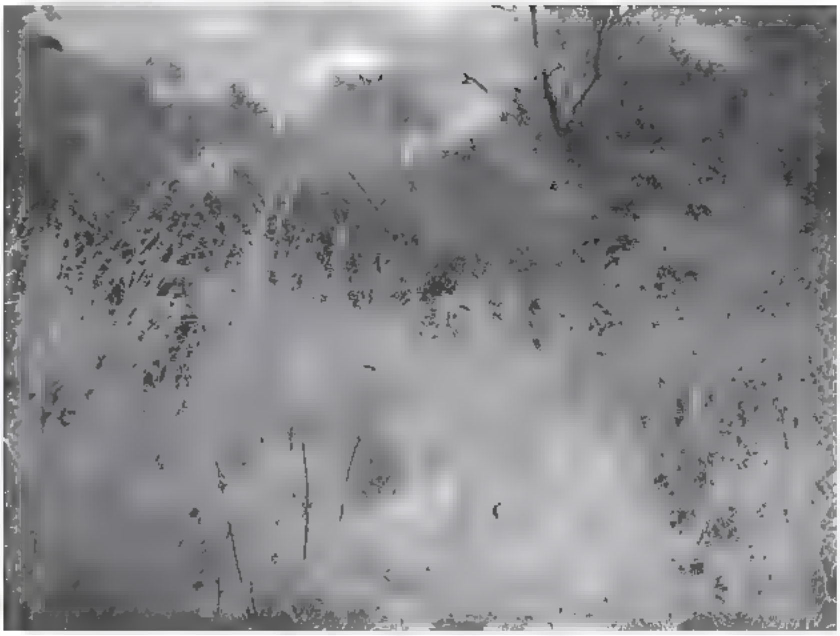


**Figure 52: Pit 1showing tall grass inside and a thicket of trees on the edges (photo by author, July 2015).**

this pit, however, indicated that top soil is composed of dark soil with lots of organic material From the profile, the colour of the soil does not change significantly What changes is the texture and the amount of organic material which decreases with depth, most probably as a result of the preservation conditions.

Pits 2 and 3

These are two larger pits immediately below the Chisikana spring One of the characteristics of the pits is that no trees have grown inside them. There is only grass which grows in these pits Pit 2 is the one immediately after the Chisikana and Pit 3 is further down. Pit 2 is surrounded by a thicket of trees and it is evident that at one point, it was used as a dumping site. Measuring approximately 30m x 15m, Pit 3 is visible from the path leading to the second entrance of the Great Enclosure

Pits 4 and 5

Approximately 100m north of Pit 3 in the direction of flow from Chisikana spring are a chain of pits. Pit 4 (20° 16' 04 5"S, 30°55' 50 4"E) measures approximately 60m x 15m (Figure 53)

Pit 5 is close to Pit 4, sharing similar environmental characteristics. Pit 5 is very close to one of the walls known as the 'inner perimeter wall' (Figure 54). The pit measures approximately 15m x 20m. The proximity of these pits


**Figure 53: Photograph showing location of Pit 4 in relation to the Curio Shop at Great Zimbabwe (photo by author, April 2017).**


**Figure 54: Picture showing position of the inner perimeter wall and its relation to Pit 5 (photo by author, July 2014).**

to inner and outer perimeter walls suggests that there was some relationship between these two archaeological features. It is possible that the walls or parts of the walls were built to control people's movements to and from these pits. It is also possible that the walls were meant to control the flow of water towards the pits.

Pits 6, 7 and 8

This is a chain of three pits located at the southern bottom of the Hill Complex, immediately behind the Curio Shop, a visitor facility that sells refreshments at the site. These pits are separated by a few meters. The pits share the same environment as well as same characteristics in terms of the vegetation and soil properties. The largest pit measures approximately 50 x 20m and the smallest among these measures approximately 15 x 20m. These pits are clear of trees; not even shrubs grow in them. The vegetation present in these pits includes the water reeds (*Phragmites australis)* and grass. Water reeds are a clear indication of a wet land or riverine environment.

Pit 9

Pit 9 (20° 15' 57.42"S, 30° 55' 52.2"E) is further down, north of Pits 4-6. It measures approximately 30 x 15m. The significance of this pit is that it is adjacent to the Watergate Path (Figure 55).

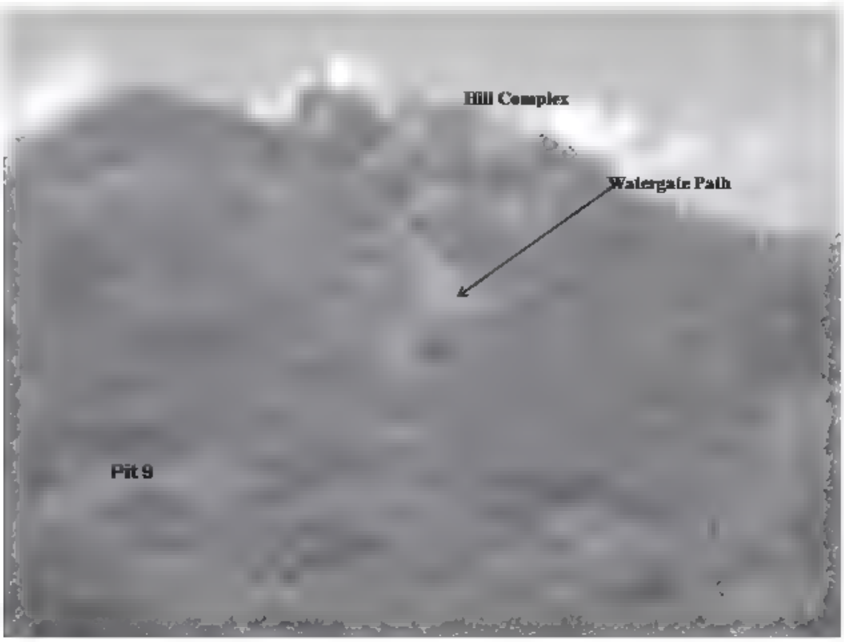



**Figure 55: Photograph showing position of Pit 9 in relation to Watergate Path (photo by author, April 2017).**

Pits 10 and 11

These are located at the eastern bottom of the small hill, where the Great Zimbabwe Hotel is situated It is probable that these pits harvested water from the granites as well as excess water from the Chisikana spring

Pits 12 and 13

Pits 12 and 13 are located behind the Valley ruins in the south east direction (see Figure 51). The pits share almost the same characteristics with other pits and they are in an environment that contains evidence that it was previously wet These pits are significant in that they are the only pits which are in close proximity to the Valley ruins. The location of these pits makes it likely for them to have served the water needs of the residents in the valley.

Pit 14

Pit 14 is located behind the Great Enclosure. This pit could have been strategically located to serve the water needs of the Great Enclosure and probably the valley during the occupation period of Great Zimbabwe.

Pit 15

Pit 15 is located just above the Rondavels, a visitor accommodation facility at the site The pit has a lot of indicators of a once wet environment (Figure 56). Among these are plenty of water reeds which grow inside this pit In addition, the pit contains water long after the other areas have dried up

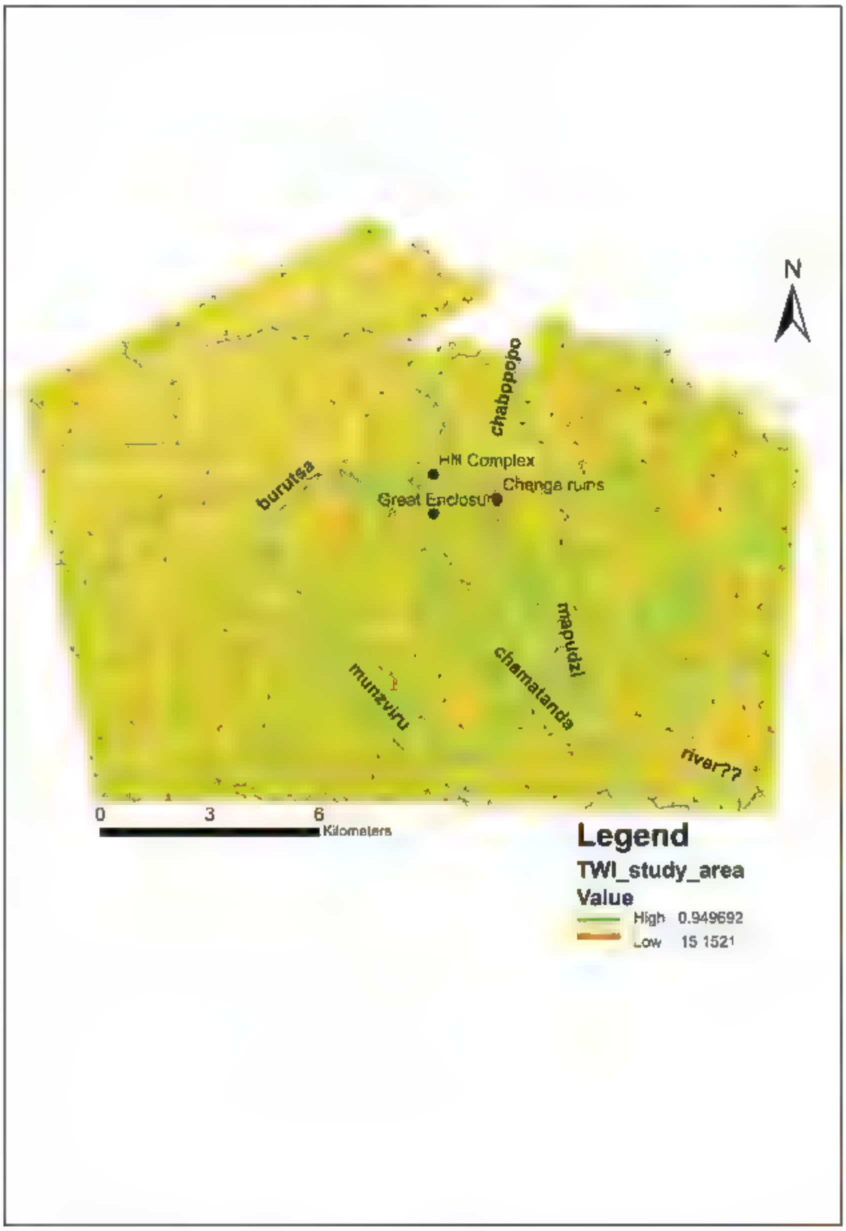
Pit 16 and 17

These are found east of the Shona village towards the Mujejeje ruins. These pits could have served the residents of the East Ruins which are located east of the Shona village

Dating of the Pits

There is no established method of dating water storing features worldwide. Beckers et al. (2013) argue that the dating of water harvesting structures is notoriously difficult such that developed chronologies are a controversial subject The reliability of radio carbon dates from water storage features is uncertain. Huckleberry et al. (2016) assert that there is need for independent empirical evidence for one to be able to date water reservoirs. An interdisciplinary investigation produces more reliable results than using a single method. For example, Huckleberry et al. (2016) combined radiocarbon dating with single grain optically stimulated luminescence (OSL), oral history accounts as well as archival records to argue for an indigenous authorship of water reservoirs along the Rio San José at Laguna Pueblo before the 19th century. One of the challenges of dating water reservoirs using radio carbon dating emanates from the fact that usually charcoal remains are rarely found in the deposits The organic material recovered in water reservoirs such as the pits at Great Zimbabwe could be younger or older than the actual deposit from which it is extracted. Against this background, water storing features require multiple methods of dating to produce reliable dates. Since the deposition of younger sediments is a common feature in

**Figure 56- Pit 6 located behind the Rondavels with water reeds (photo by author, July 2014).**



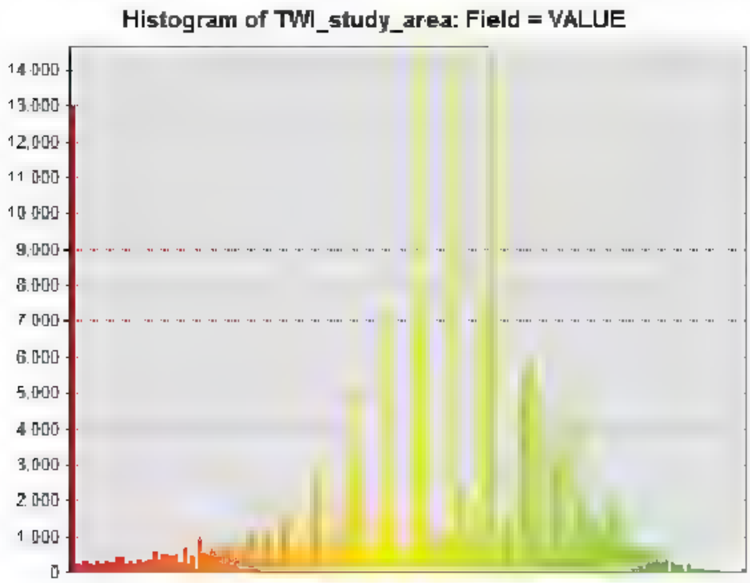




**Figure 57: Topographic Wetness Index (a) and histogram for the study area (b).**

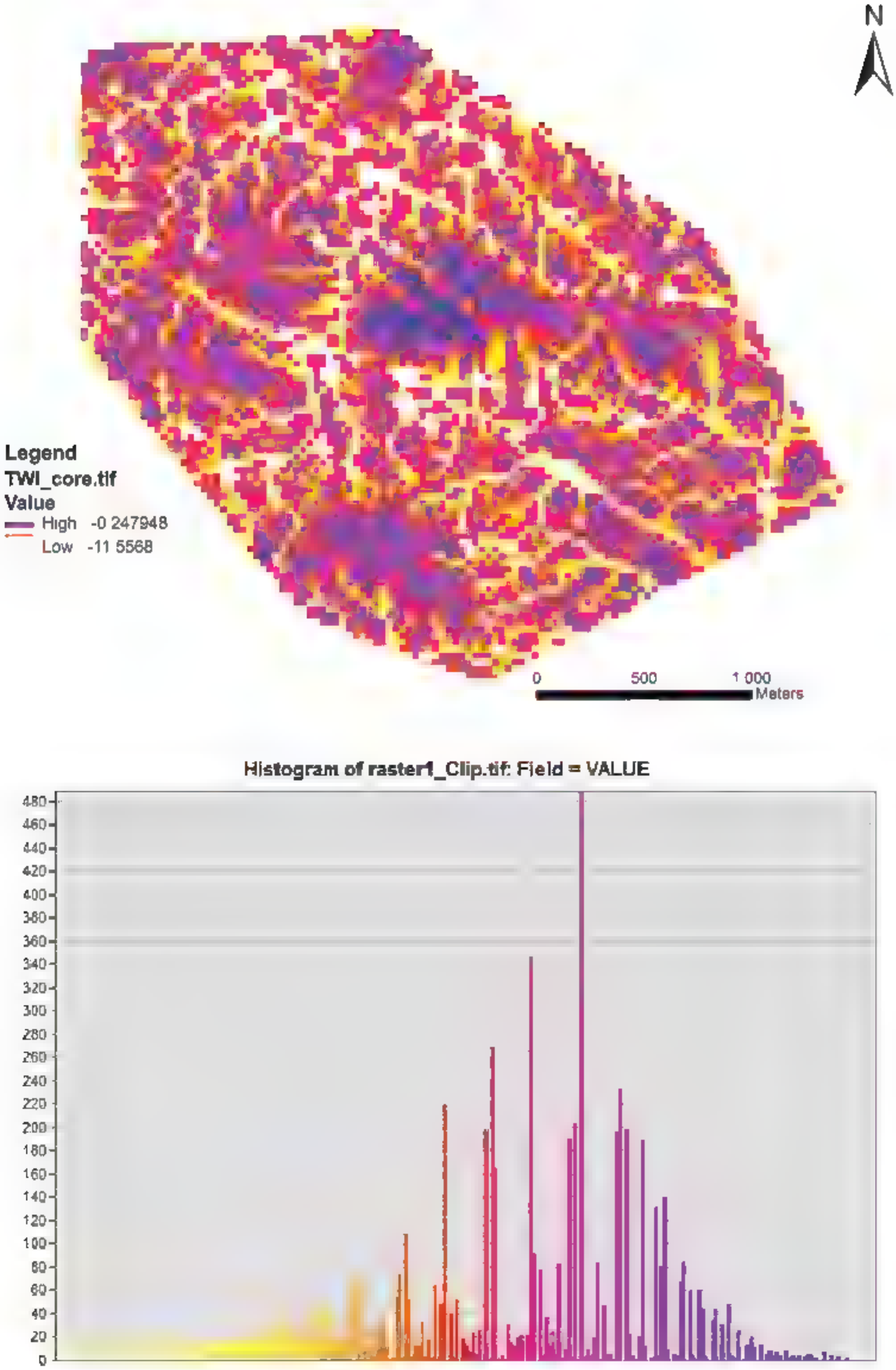



**Figure 58: Topographic Wetness Index and histogram for the Great Zimbabwe core area.**

depressions, radio carbon dates can arguably be younger than the dates of the rest of the deposits. The actions of water and wind can pile new deposits in these pits Preliminary radio carbon dates obtained by the Blue Skies project are currently under analysis and are yet to return usable dating for the deposits inside the *dhaka* pits. This further illustrates the unresolved challenges of obtaining absolute dating of water- related features.

*Pits and Water at Great Zimbabwe*

Except for a few structures in the Valley Ruins, most of the walls are situated in areas of less flow accumulation. This is a departure from the observed *dhaka* pits at Great Zimbabwe, which are within the automated stream networks. Although these *dhaka* pits are found in stream networks, they are within the moderate flow accumulation

zones. This suggests that the pits are artificial in their origin. There is a possibility of the creation of the pits by damming so as to provide water for the people at Great Zimbabwe. The *dhaka* pits can thus be explained as products of damming so as to contain the surface runoff from the springs as well as the rainwater.

### 5.4 Topographic Wetness Index

Having configured the watershed, a Topographic Wetness Index analysis was also carried out in the research area with a focus on Great Zimbabwe. Topographic Wetness Index (TWI) is also known as the Compound Topographic Index (CTI) which is defined as steady-state wetness. TWI is used to map the spatial distribution of moisture content and also to predict areas with high soil moisture such as wetlands as well as delineating them. Archaeologically, the TWI can be used in the detection of once wet areas and hypothesise on the use thereof, based on other related features. The TWI function was developed by Bevan and Kirkby (1979). It is a function used in hydrological processes to quantify topographical control. The algorithm used to get the wetness index is:

$$\ln(a/\tan b)$$

where (a) is the upstream contributing area and (b) is slope raster (Bevan and Kirkby 1979). The index is therefore a product of slope and the upstream contributing area in relation to flow direction. As indicated by Sorensen et al. (2006), topography is first order control, responsible for the variations in hydrological processes. Thus, topography forms the basis for the calculation of the TWI. According to Grabs et al. (2009), topography controls the patterning of saturated areas and this has a bearing on soils, hydrological processes as well as stream quality. According to Schimdt and Persson (2003: 179), topography is one of the most important natural factors responsible for heterogeneity on arable lands. It is in this regard that the wetness index has been widely used as a descriptor of wetness in catchments (Grabs et al. 2009). For Great Zimbabwe, the high values correspond to low lying areas with gentle surfaces and these keep soil moisture for longer. The Great Zimbabwe landscape has many areas with high values and ground truthing attested to this. It is therefore, possible that the areas with high wetness values could have been present during the occupation period of Great Zimbabwe.

Results indicate that most of the areas generally have high soil moisture. The TWI was classified using arbitrary threshold and results are presented in Figure 57 and 58. In the TWI, drainage depressions are represented by higher values whereas the lower values are crests and ridges (Yang et al. 2005). The drier areas are depicted by lesser values. Depending on the threshold used in classification, the topographic wetness index is also used to predict wetlands within the core of Great Zimbabwe. The prediction of wetlands is based on the assumption that the groundwater table also follows topography. There is also a correlation between the TWI index and other soil characteristics such as organic matter content, silt percentage and depth (Grabs et al. 2009). The TWI could also be used in the characterisation of vegetation since the variability of most plant species depends on available soil moisture.

### 5.5 Conclusion

From hydrological modelling, it is clear that the inhabitants of Great Zimbabwe remained reliant on nature to provide their water needs. The absence of visible and 'so obvious' water management systems such as cisterns does not necessarily mean there was no water management in place at Great Zimbabwe. As highlighted in the chapter, by using DEMs, one can create models of hydrology and be able to make sound judgements based on those models. The hydrological models created have indicated a high count of water accumulation around the Great Zimbabwe and this could have had an implication on the Great Zimbabwe settlement choices.

Hydrological modelling offers a window into the relative availability of water in an area, particularly in the absence of expensive paleoenvironmental data (Hill et al. 2007). One major critique of hydrological modelling in archaeology is that it is 'environmentally deterministic'. Wheatley and Gillings (2002) argue that there are several factors that affect drainage that are not considered and these include changing land use patterns and construction of some structures which also affect reconstruction of hydrology models. The other shortcoming of hydrology models in explaining the past is the issue of changes in environmental and climatic conditions. Models usually use available current data, which might be very different from past environments. Although hydrological modelling is environmentally deterministic, it helps in providing a more vivid picture of how the hydrology of an area was like by showing topography in relation to water flow, as well as predicting the location of wetlands. Therefore, in spite of the stated shortcomings, hydrological modelling remains vital for an understanding of water and the environment at ancient cities such as Great Zimbabwe. It is therefore imperative for one to do some form of hydrological modelling to understand the archaeological landscape-water relationship.

# 6

# Simulation of Cultural Processes at Great Zimbabwe

## 6.1 Introduction

The previous chapter discussed known as well as potential water capacities of Great Zimbabwe through hydrological modelling. It also established that water was a critical resource in the everyday lives of people in the ancient city. Archaeological evidence pointing to the use of water and water engineering include, among other things, the *dhaka* floors (made from mixing clay and water), drain holes in the stone walled structures and also evidence of transportation of water from the numerous potsherds of clay pots typically used in ferrying water. Using a number of GIS tools and techniques in spatial studies, this chapter examines and simulates the processes of transportation of water from various known sources to the built up areas where it was used for various purposes. It simulates routes and uses Least Cost Analysis to establish water sources which were potentially exploited more regularly than others.

The study mainly uses topography to simulate the movement of people from water sources and to test these routes against known routes. Models produced in this chapter are therefore topography-dependent. The accessibility of water as a resource offers insights into the site's catchment. It also offers insights into factors such as the reasons for the choice of a settlement as well as the engineering skills that were used to traverse various gradients. It is within the framework of traversing a landscape that topography plays a fundamental role in the trajectory of such movements (Fiz and Orengo 2007: 316). These movement models have proved efficient in suggesting least cost routes in mountainous environments. However, they do not explain the setting of communication routes in flat to gentle slopes designed not only for the movement of people but also for goods. Further, the models do not account for cultural and religious considerations in the choice of some routes over others. Using concepts of space syntax, the chapter examines space configurations – the means by which spaces acquire social significance and the consequences thereafter (Griffiths 2012).

The cost surface analysis, which is part of space syntax analysis, used in the chapter builds up to the simulation of movement of people mainly from known as well as potential water sources to consumption areas. In the chapter, consumption areas refer to the built environment. This, however, does not mean that water was not a critical resource outside the built structures. The chapter presents the results of the cost surface analysis that have been done within the Great Zimbabwe landscape with the aim of simulating movements of people mainly for water collection purposes Water is a critical component used for both industrial and domestic purposes. Thus, the discussion examines water in its various functional states.

## 6.2 Conceptual and Methodological Approaches

The cost surface analysis falls within the broader catchment analysis. When defining territories using cost surface analysis, simple distance based boundaries are replaced by those based on gravity rules (Dixon and Uddameri 2016: 172). Thus, as put across by Van Leusen (1999), rules of energy expenditure are then used to define boundaries for accumulating costs and cut off points The cost surface analysis was done in ARCGIS toolbox (the Spatial Analyst). The cost surface analysis assigns friction to movements within the landscape. The model that was employed acknowledges the anisotropic nature of landscape. This means that the effort required to go uphill is different from that needed to go downhill (Herzog 2014: 227). Thus the effort of traversing a cell with a given slope value depends on the direction of movement (De Silva and Pizziolo 2001). Using slope as a determinant, the cost of traversing downhill is different from the one needed to go uphill. Rather than using just the distance between two points as a factor in determining movement from water sources, the slope is considered to be the crucial factor. In calculating the effort of traversing a particular landscape, both slope and distance were considered to be key factors

Least cost analysis of water provision, therefore, involves determining the most efficient routes in ferrying water from water sources to the dwelling areas. The analysis also predicts probable routes that could have been used to transport water from its various sources to consumption areas. The analysis also assumes that there was interaction between various spaces within the Great Zimbabwe settlement. Some of the interactions involved the distribution or transportation of resources such as water Based on ethnographic data, it is assumed that water was carried in clay pots from the water sources to the built structures. Using a scale of 1 to 10, with 10 representing the most difficult, the costs of fetching water from the water sources were modelled. Bell and Lock (2000: 88) note the importance of topography in influencing movement and highlight that in most cases, it becomes the starting point in calculating the cost of traversing a certain landscape Topography has always acted as a key constraint to movement (Chandio et al. 2012: 907).

Catchments were created so as to get an insight into the area which could have had its supplies from the various water sources. Rather than using a simple radius to

determine a catchment area, buffers were created based on the effort needed. Here cost surfaces were used since the energy needed to traverse different terrains varies. The cost surfaces show the cumulative cost of reaching a target point from surrounding regions. Friction such as topography is then used to create least cost paths, that is, routes that require the least effort. The unweighted cost surface assumes, for example, that traversing a 40 degree slope requires twice as much effort as traversing a 20 degree slope (Bell and Lock 2000). In reality, the energy required to traverse these gradients is not as simple as is given in the unweighted cost surface analysis. Thus, for the catchments of the springs, the weighted cost surface was produced using Bell and Lock (2000: 87)'s tan(x)/tan (1°) equation which derives the relative slope-related cost from the ratio between its tangent and the tangent of 1°. According to Bell and Lock (2000: 88), in cost surface analysis, the cost of climbing a slope is not directly proportional to the degree of the slope. They give an example where going up a 45 degree slope is not 45 times as difficult as moving on flat ground or a 0 degree slope. Rather, they emphasise the complexity of the relationship. The product is a non-linear relationship between slope and cost (Van Leusen 2002). For slopes steeper than 25°, the ratio becomes very significant. According to Van Leusen (2002), if costs are weighted, accumulation proceeds with different degrees of ease over any particular cost surface. Against this background, the weighted cost surface analysis was done for the springs around Great Zimbabwe known to be perennial both in ethnographic and historical records. The idea is to get the sphere of influence for the various springs spread across the study area.

One way of producing catchments is through the use of polygons. These are useful when considering water sources as indicators of territorial or spatial tendencies of the past populations. However, the process of producing the polygons (tessellation) creates a homogeneous and featureless plain which does not consider topography in determining catchment areas. Consequently, a weighted allocation which takes cognisance of the variability of the landscape was used. According to Van-Leusen (2002: 64), the process of assigning territories to sites assumes that the landscape is flat and two dimensional. This assumes that resistance to movement across the landscape is isotropic, which means that movement in all directions requires the same effort. However, as will be elaborated later, in the real world, the size and shape of a catchment area or territory would be much more variable. Factors such as terrain, topography, and gradient among others, have a bearing on the effort needed to traverse the landscape. The utilisation of resources such as water decreases gradually with distance from the source rather that the sudden binary map produced by tessellation. Tessellation shows an abrupt change in the exploitation of a resource (from 0 to 1), where an area is either 'within' or 'out' of a catchment. It is in this regard that it was found prudent to utilise a cost weighted analysis because it takes cognisance of the terrain (Bell and Lock 2000).

The use of the euclidean (straight line) distance is contrasted with the use of the weighted algorithm which assumes that terrain has a greater effect on the energy required to traverse a landscape (Van Leusen 1999; Bell and Lock 2000; Herzog 2013). The cost surface analysis uses the default function in ESRI ArcGIS toolbox, the Path Distance, which already incorporates the weighted algorithm (Verhagen and Jeneson 2012). The weighted cost surface GIS functionality has been widely popular for its ability to improve a simple 'flat' geographical space to a more complex geographical space where relevant properties are used in the drawing of boundaries (Dixon and Uddameri 2016). Distance based boundaries are replaced by gravity based distance rules. The energy required to move from the water source is dependent on the friction that the topography exerts rather than distance alone.

From a landscape archaeology perspective, the idea behind modelling movement is to understand how past societies interacted with their landscapes. The analysis works on the assumption that people would make use of favourable terrain in carrying water from water sources to consumption areas. Having established the catchments of the springs and having assumed that these springs were major sources of domestic water for the ancient city, routes were simulated according to how various settlements could have obtained their water. The effort or cost required to reach various areas from Chisikana spring, one of the main water sources at Great Zimbabwe, was calculated.

## 6.3 Catchment Areas for Known and Potential Water Sources at Great Zimbabwe

### *6.3.1 Springs Catchments by Thiesen (Voronoi) Polygons*

The cost surface was initially produced to delimit the catchment of potential water sources in the form of springs and wells. Springs were identified through ethnographic and archaeological research (see Chapter 3). Currently, functional as well as known extinct springs have been taken to represent the water sources in the study area. Thus, the ethnographic present is critical in determining water resources in the past. Catchments were initially generated through the calculation of Thiessen or Voronoi polygons. In Thiesen polygons, a territory is assigned to a site nearest to it through tessellation (van-Leusen 2002). By using tessellation, each cell in the map is allocated to the 'territory' of the nearest spring. The product of tessellation is a choropleth map with absolute boundaries (Figure 59). This allows one to determine the patterns of exploitation of the available water sources around Great Zimbabwe. For the catchment of springs around Great Zimbabwe, it translates to two variables; either people use the water source or they do not.

The Thiesen polygons (Figure 59) also show the catchment areas of the various water sources around Great Zimbabwe


**Figure 59: Thiesen (Voronoi) polygons of springs around Great Zimbabwe.**

From the tessellation, it is evident that most of the built up areas fall within the Chisikana spring territory.

Thiesen polygons were also calculated for the core of Great Zimbabwe. The greater part of the monument falls within the area supplied by Chisikana spring. Other springs that can supply water to the Great Zimbabwe are Daitai 1, located east of Great Zimbabwe, Heroes 1/ Wayside located along Morgenster Road, as well as another spring in Daitai area and Chinama in Mukungwa area south east of Great Zimbabwe (Figure 60). Except for Chisikana spring, these are active springs from which nearby communities obtain their water for daily use. Chisikana, Wayside/Heroes, Daitai and Chinama must have been exploited regularly by people at Great Zimbabwe.

Figure 60 shows the main water sources exploited at Great Zimbabwe. From the polygon, it is evident that some water sources which are currently in use or known to have been used in the recent past and pre-colonial times would have been utilised by the people at Great Zimbabwe. The Thiesen polygons defined the catchments or territories for the various springs. However, in defining these, social factors such as taboos and restrictions to the springs are not considered. Sacred springs usually have taboos around them which become part of the water management regime. Chisikana is a spring which is imbued with such taboos (Fontein 2006a, 2006b). From the Thiesen polygons calculated, it is possible to estimate the number of people utilising a spring.

### *6.3.2 Landscape Resistance to Movement to and from Water Sources around Great Zimbabwe*

Cost surface analysis was performed using gradient as the main factor in landscape resistance to movement. The slope map of the study area as well as the histograms are shown in Figures 61 and 62 below.

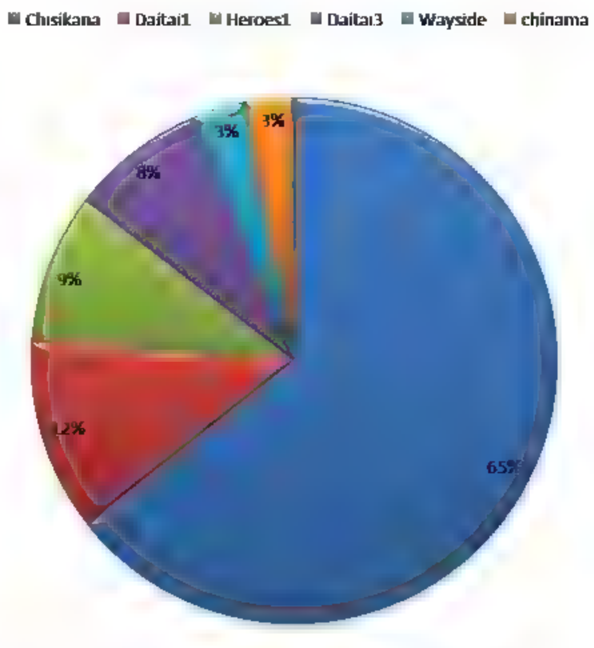



**Figure 60: The area of land within the national monument serviced by different springs.**

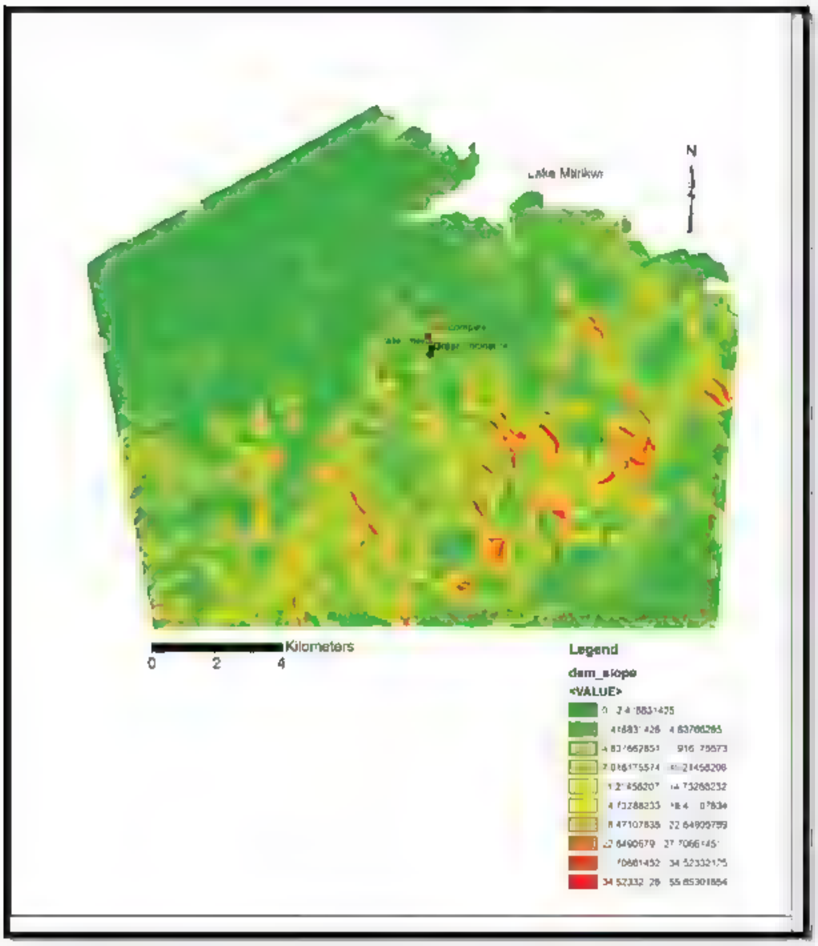
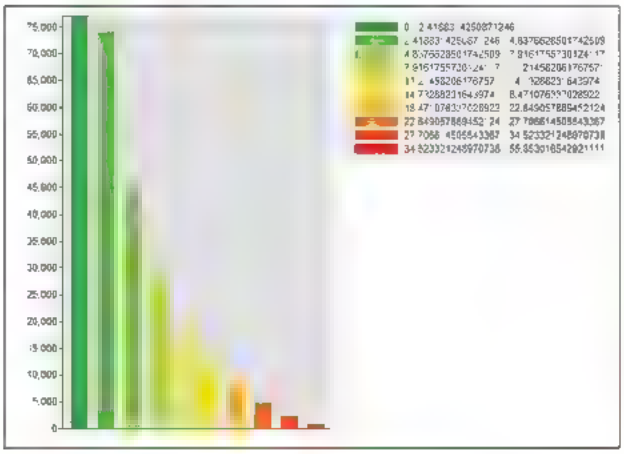



**Figure 61: Slope map of the study area.**



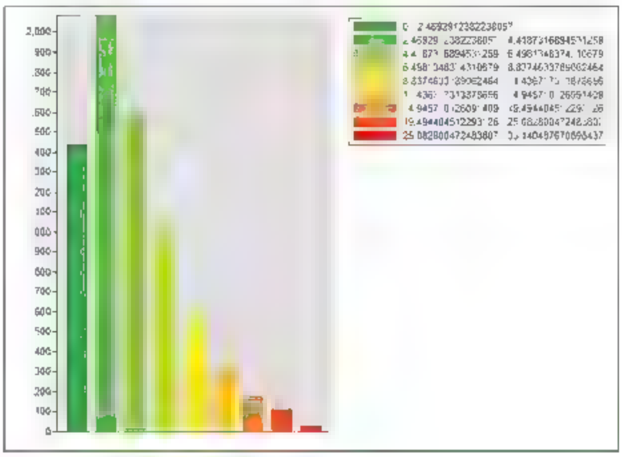


**Figure 62: Histogram of Slope values in degrees of the study area (a) and of the core area (b).**

Great Zimbabwe is situated in an area characterised by hills and mountains. Consequently, it is not unusual to find slopes of various degrees. The slope map was derived from the DEM. The study area is characterised by slopes which range from 0-55°. The areas with the highest slopes are located in the south and south east of the Great Zimbabwe core area. However, within the core area as indicated (Figure 62), the slopes range from 0 to 33°. The histogram indicates that the bulk of the land surface in the study area generally falls under gentle slopes of between 0 and 5°. Very steep slopes are also found in the area, and these are between 27 and 60°. Steep slopes are a characteristic feature of the Hill Complex where the highest values have been recorded (58°). There are some parts of the area containing steeper slopes such as the ones that are found east and south of the Hill Complex (Figure 63). These are individual cases which are not considered as the slope value is an average between two points. That means

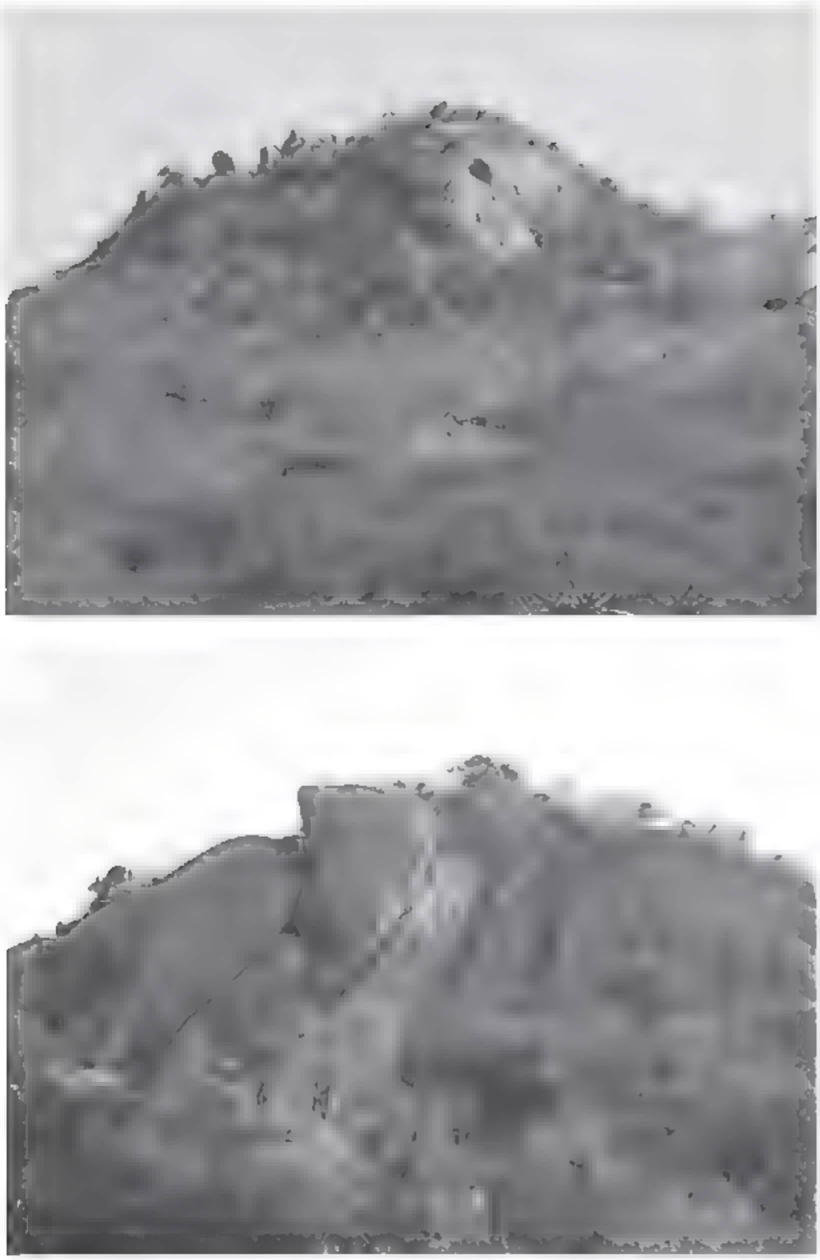


**Figure 63: The cliffs that characterise the south (a) and eastern (b) sides of the Hill Complex (photos by author).**

they are steeper as well as more gentle slopes within the average slope cell In that case, in each cell, sections with varying slopes can be found Thus, features such as cliffs do not show up in the calculation but these are very clear from the contours on the topographic map.

The analysis acknowledges terrain as a fundamental factor that determines the cost of traversing the Great Zimbabwe landscape Initial cost surfaces were created for all the springs and the result is a cumulative cost surface map (see Figure 65). The effort of traversing the landscape from all the springs is put on a scale of 1 up to 5, with 1 requiring the least effort

From the cost surface analysis, most of the Great Zimbabwe area is within the area regarded as requiring the least effort to obtain water from the springs This is to be expected given the location of the springs, a factor influenced by the underlying geology The cost surface considers effort in getting water from a spring irrespective of the nature of the spring. Thus, all springs are considered in this analysis There are however some areas which require more effort in getting water even within the Great Zimbabwe core area A zoom-in on the core of Great Zimbabwe (Figure 66) shows that areas such as the summit in the Hill Complex falls within scale 2, hence more effort is needed compared to other areas.

Cost surfaces were created for selected springs based on proximity to the Great Zimbabwe built environment The cost surface analysis was done so as to obtain an insight into the accessibility of water at Great Zimbabwe. Other water sources at Great Zimbabwe include the marsh (*dambo*) at the bottom west side of the Hill Complex.

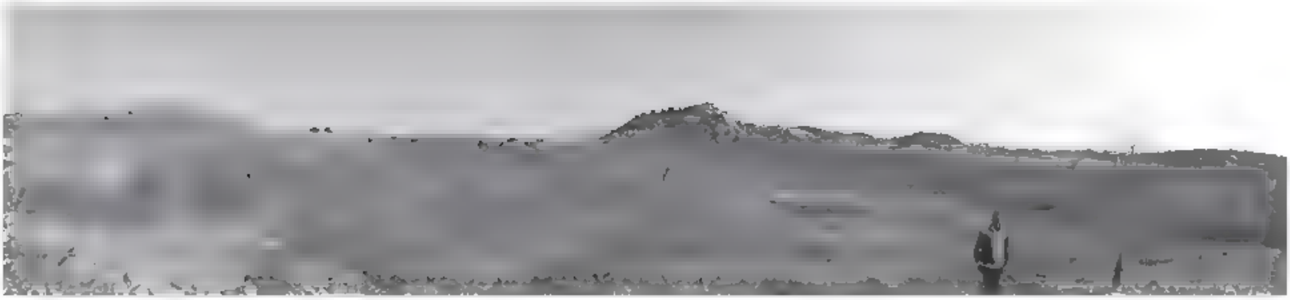


**Figure 64: A panoramic view of the landscape, showing Hill Complex in the background (photo by author).**

There are some *dhaka* pits adjacent to this marsh, and it is likely that these developed progressively as a result of attempts to manage adjacent reservoirs.

### *6.3.3 Chisikana Spring*

Chisikana spring (-20° 16' 20.0064"S, 30° 55' 56.6292"E) lies within the confines of Great Zimbabwe. The spring is located about 200m north west of the Great Enclosure. It is historically known to be a perennial spring and a source of water for the Great Zimbabwe area in various periods (Hall 1905a). Thus, Chisikana is central to the understanding of water needs and sources at Great Zimbabwe.

The use of different algorithms in the production of cost surfaces was demonstrated using the Chisikana spring as a case study. The first analysis for the Chisikana spring involved creating a catchment using the euclidean distance or the unweighted algorithm. The result was an isotropic surface where energy needed to traverse the landscape is the same in all directions. Figure 67 shows the sphere of influence of the Chisikana spring in concentric circles. It shows the uniform increase of effort as one moves away from it.

The weighted cost surface considers terrain of traversing the landscape (Figure 68). Though some areas are close

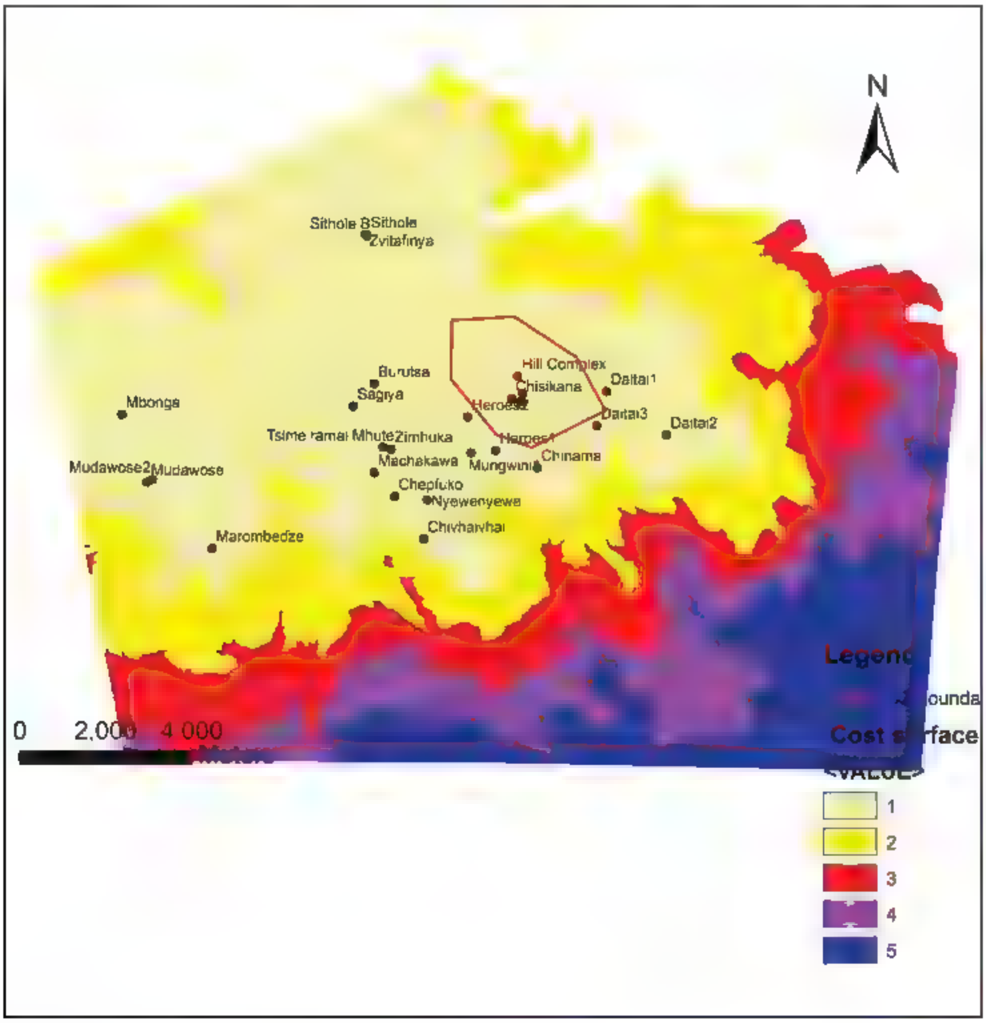



**Figure 65: Terrain based cost surface for all springs in the study area.**

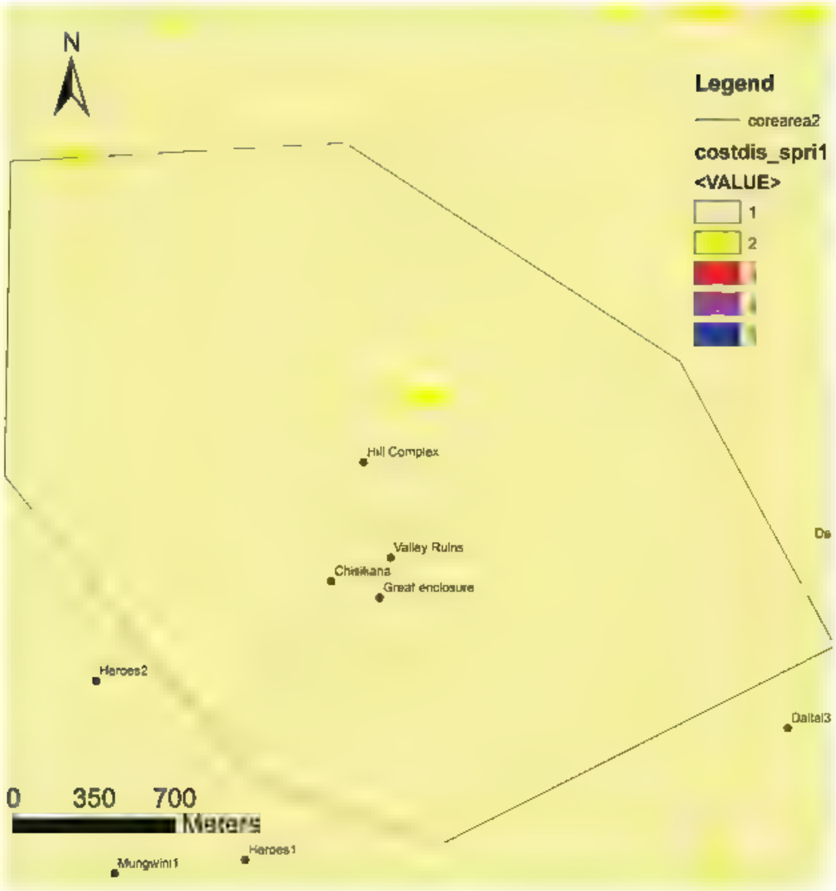



Figure 66: A zoom in of the Great Zimbabwe cost surfaces – the highlighted areas are on scale 2 with regard to the effort needed to obtain water from any spring.

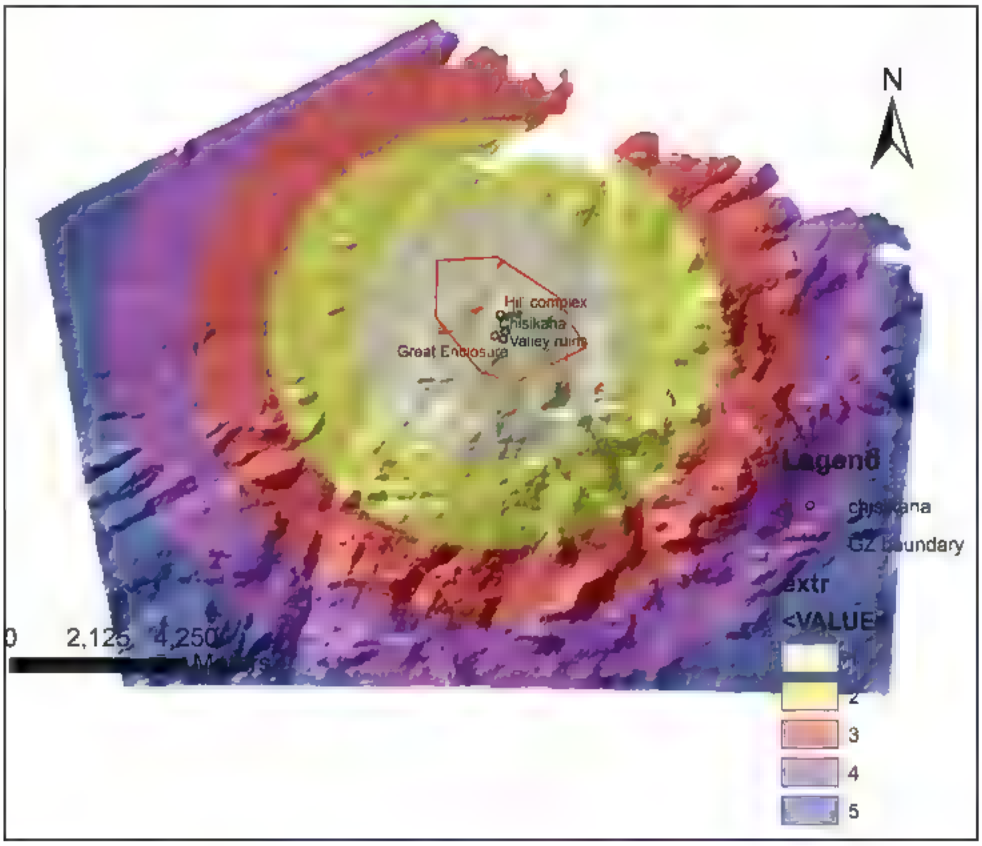



Figure 67: Concentric circles produced by a method that uses proximity to Chisikana spring

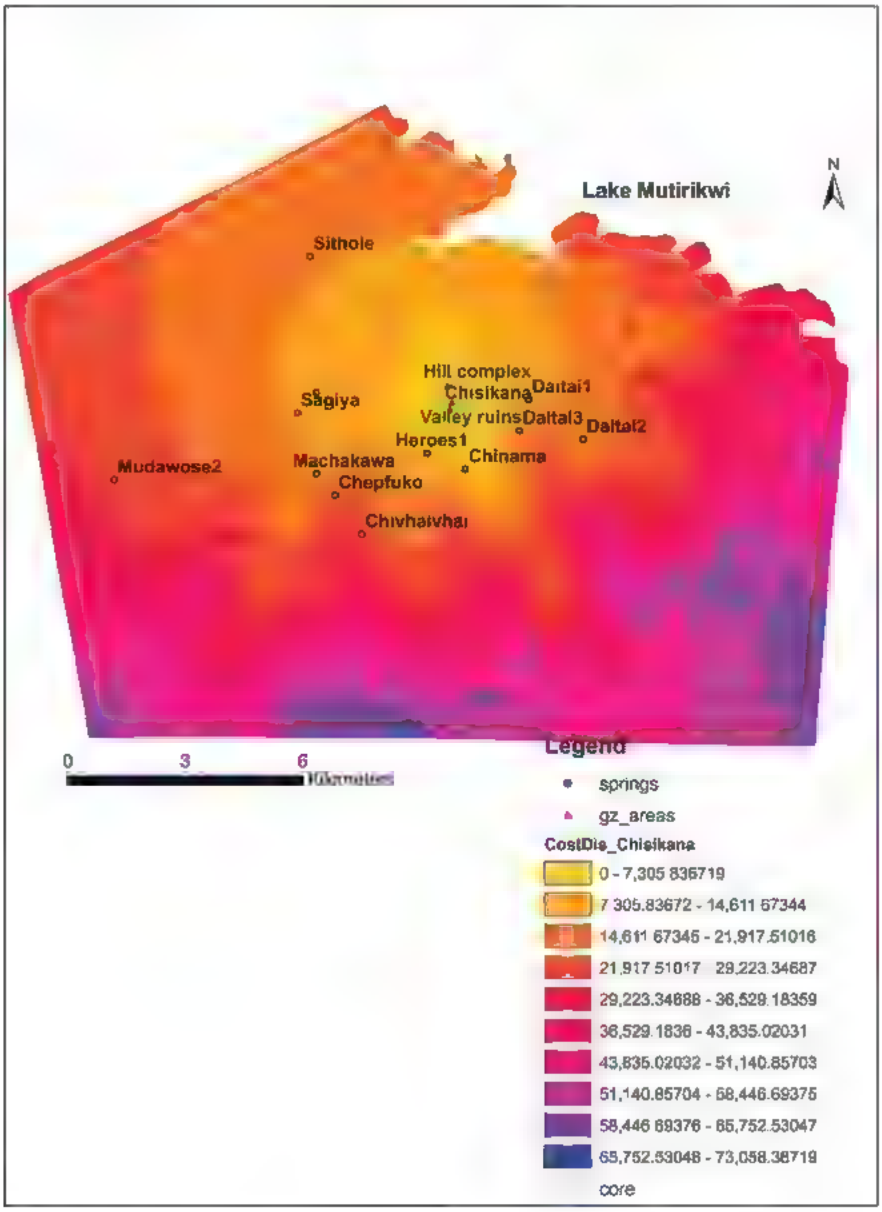



**Figure 68: Weighted cost surface for Chisikana spring.**

to the spring, the topography requires more effort to reach it. The Hill Complex illustrated above (Figure 68) is an example, falling in level 2, which requires more effort compared to areas in category 1. Thus, even though the Hill Complex is only 500m away from the Chisikana Spring, the energy that is required to get to the spring is similar to the energy required to get to Mungwini village, which is some 4km south west of Great Zimbabwe. This is due to the steep slopes around the Hill Complex. Considering terrain as the main factor in influencing movement, most areas within the built up area of Great Zimbabwe are easily accessible from Chisikana spring. Although it is no longer running, it is well documented that it provided water to the Great Zimbabwe population in pre-colonial times (Hall 1905a). Before the desecration and closure of the spring during the colonial period, it was an important source of water for the Great Zimbabwe city (Hall 1905a; Fontein 2006a, 2006b, Matenga 2011; Pikirayi et al. 2016)

### *6.3.4 Wayside Spring*

In relation to Great Zimbabwe, Wayside spring (30° 55' 44.5" E, 20° 16' 59.1" S) is located just outside the boundary of the area declared a national monument. Between the spring and the built environment of Great Zimbabwe is a hill. Wayside spring is located along the Great Zimbabwe-Morgenster road, a few metres from the main road. The spring is on the edge of a whaleback (*dwala*) granite, and coupled with the vegetation, makes it invisible to a person who is not familiar with the place. It is marked by a waterberry (*mukute*), ficuslutea (*mupawa)* and fig tree (*muonde)* and a granite terrain. Wayside spring is one of the springs that exhibit the complicated nature of the underground water in the Great Zimbabwe area. The presence of the whalebacks around the spring reduces the probability of getting access to underground water to an ordinary eye.

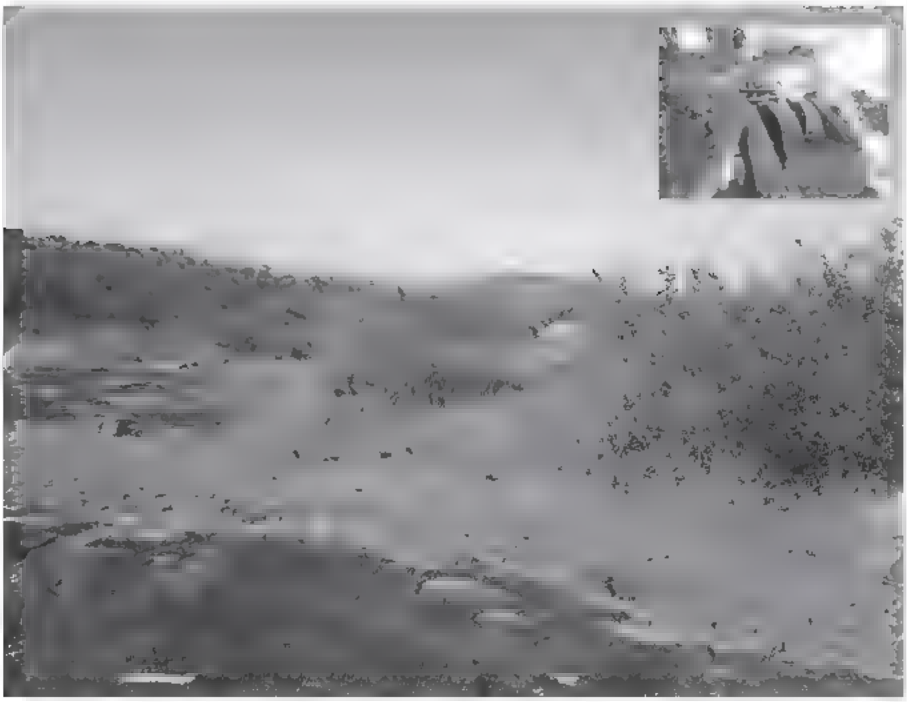


**Figure 69: Area just below the Wayside spring and the Wayside spring (insert) (photo by author).**

The spring occurs in a granite landscape, where water disappears into the cracks on the garnite rocks and reapears on the slopes. Thus, the underlying geology makes water to dissappear into the cracks and reappear downstream. Its proximity to the built environment of the Great Zimbabwe led to the need to assess the effort that would be needed to get water from the spring. The need to examine the efforts that would be required is also based on historical accounts that document how water for use at the Great Zimbabwe Hotel would sometimes be obtained from as far as Chamatanda which is about a kilometre further away from the Wayside spring. Thus, it is highly probable that water could also have been obtained from this perrenial spring, especially during the dry season.

Figure 70 shows the cumulative effort that would be required to move from the Wayside spring based on topography. Class I represents areas that require the least

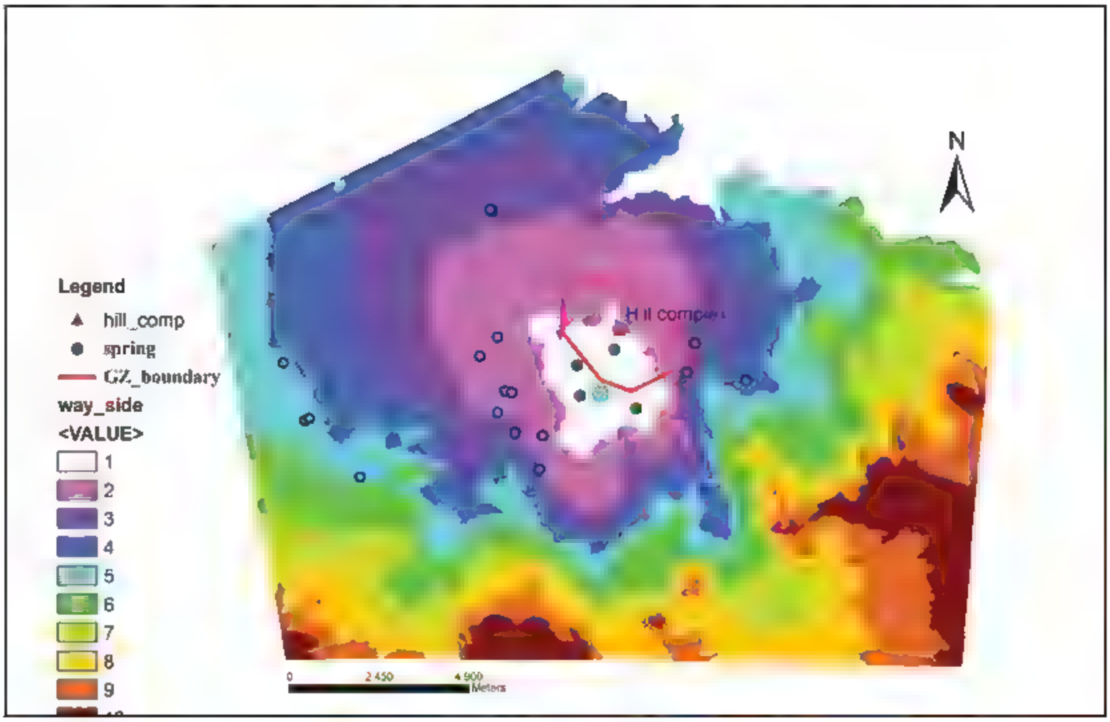



**Figure 70: Cost surface for Wayside spring.**

**Figure 71: Clear water of Machakawa spring (photo by author).**

effort whereas class 10 represent the most difficult areas to reach from the spring. From the illustration, some of the areas within the core of Great Zimbabwe such as the Great Enclosure and the valley ruins are within the least cost areas of the Wayside spring. The implication is that it is possible for residents at Great Zimbabwe to have obtained water from this source without using much effort However, areas such as the Hill Complex fall in class 2, thus requiring more effort to reach from the Wayside spring The cost surface analysis indicates that the north side of the spring requires less effort than the south. This is attributed to the topography, which is characterised by hills and valleys between Wayside Spring and the core of Great Zimbabwe

### *6.3.5 Machakawa Spring*

The Machakawa Spring (30° 54'13" E, 20° 17' 16"S) is located south-west of Nemanwa Growth Point Whereas most springs have their water from below the surface, the Machakawa Spring water flows from the side of a ridge as shown in Figure 71

The Machakawa spring illustrates how the Great Zimbabwe area is recharged by underground water Crevices in the granite rocks act as underground streams The main significance of Machakawa spring is that it is perennial, providing enough water to supply the needs of the communities around it. Cost surface analysis was done to assess the effort that would have been needed to get water from this spring given the topography and the distance of about 4 km from the site The Machakawa spring is in a valley surrounded by several hills. Between Machakawa Spring and Great Zimbabwe, there are several hills, which make it unlikely that people would have travelled to get water from it

Figure 72 shows the scaled cost surface from 1 to 10, with class 10 requiring the most effort. The areas within the zone declared to be the national monument are falling within 2 and 3 scale Thus, it required much more effort to obtain water from the Machakawa spring. For the built environment at Great Zimbabwe, the cost surface analysis indicates that most of the core area of Great Zimbabwe falls within scale 3, which means more effort would have been to fetch water from the Machakawa Spring. Thus, the energy required to traverse the landscape from Machakawa to Great Zimbabwe was quite significant. Therefore, it is unlikely that the people at Great Zimbabwe obtained water for everyday use from that source. However, it is possible that the spring might have been used during droughts given the fact that it is perennial.

## 6.4 Determining Water Supply Routes at Great Zimbabwe

The water supply networks were analysed for the core of Great Zimbabwe, the area that has been declared a national monument, and comprising open spaces as well as stone walled structures. In the core area, there is considerable archaeological and ethnographic data which suggest that water was ferried from elsewhere to the built areas of the ancient city Some of the evidence is in the form of broken potsherds from clay pots typically used for fetching water today and during pre-colonial times The potsherds also show no evidence of soot which further suggests that they were mainly or only used for fetching and storing liquids, among them, water. Thus, available evidence dismisses

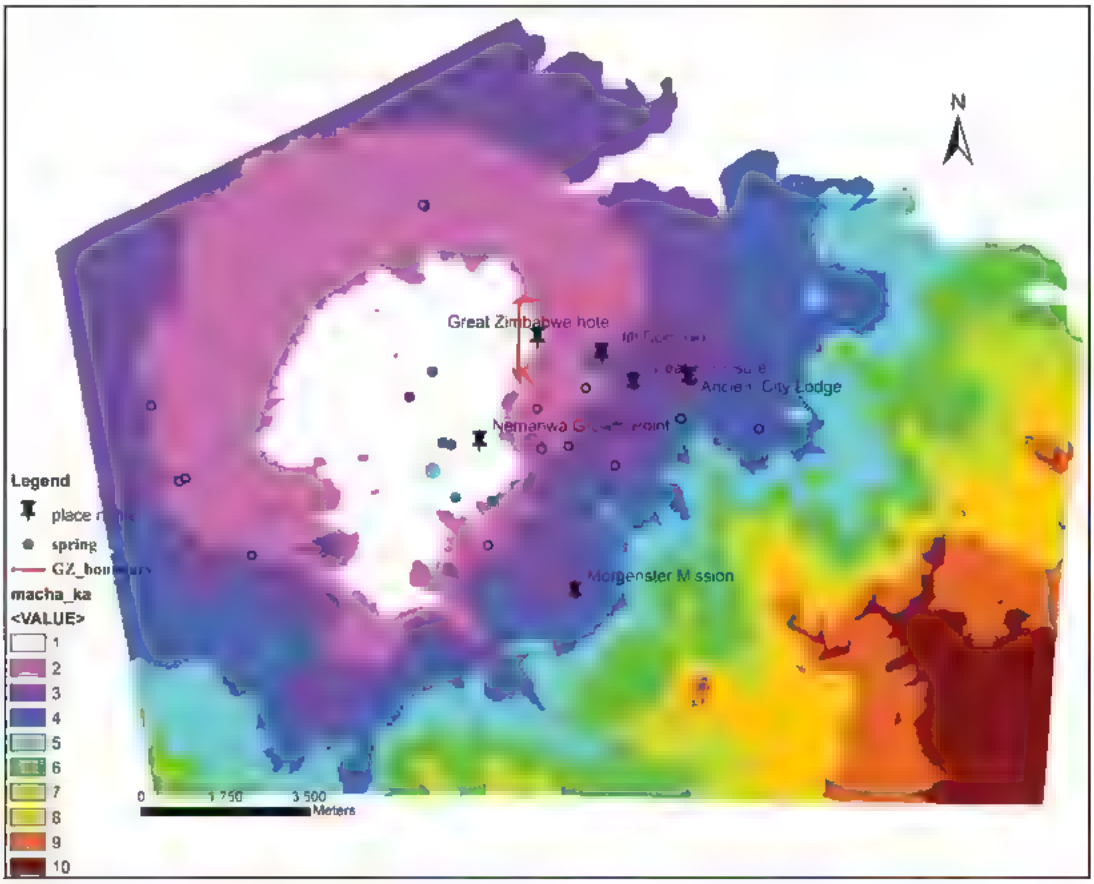



**Figure 72: Cost Surface for Machakawa Spring.**

assumptions that water could have been used in situ or diverted using some engineering skills. It is evident that water was carried using containers. Potsherds from broken pots typically used for carrying and storing water show that water was fetched from various sources and transported to areas such as the Hill Complex and other structures where it was consumed. The concentration of these potsherds in one of the paths which leads to the Hill Complex from the western side of the hill has made some scholars to refer to this path as the 'Water Path' (Hall 1905a: 8). This suggests that the path was largely used for ferrying water up the hill. This argument is further strengthened by the fact that no water sources have been found within the Hill Complex. This suggests that water was ferried from areas below the summit of the Hill Complex.

Against the background, it is necessary to analyse the possible routes used for ferrying water to various areas of the built environment at Great Zimbabwe. The analysis done here has examined the most energy efficient routes from water sources to various habitation sites. The analysis also involves a comparison of simulated paths against known routes such as the 'Watergate Path' as well as the 'Ancient Path'. Least cost paths were calculated using cost surface analysis GIS tools. Other considerations like the absence of big rivers which, in some cases, could affect movement were also taken into account in the analysis. As maintained by De Silva and Pizziolo (2001), both natural and cultural elements have an impact on the nature of movements on a landscape. Although socio-political factors are also important determinants of movement, they are difficult to employ in the absence of good ethnographic data and are also problematic to input in the available GIS tools.

Movement has been modelled with a focus on the transportation of water. It is observed that the most used route in a homestead is that which leads to a water source. Analysis of least cost paths involves identifying optimal routes between two points, which is achieved by minimising costs. The analysis done does not take into consideration other factors that can affect movement such as social or cultural factors. Instead, it relies on least cost energy from a physical perspective. The assumption is that physical energy was sorely responsible for the decisions made by the inhabitants of Great Zimbabwe in their quest to find routes from the various water sources to the dwelling areas within the site. Factors like taboos and social restrictions are also important considerations. In spite of that, physical or topographic factors remain vital in people's decision making process when it comes to choosing routes.

The first analysis looks at one way from the water sources to utilisation areas, and then the other analysis looks at the round trip considering the anisotropic nature of landscapes. Isotropic and anisotropic analysis relates to friction that affects movement from a physical point of view (De Silva


**Figure 73: Model for the creation of the least cost path from Chisikana to Hill Complex.**

and Pizziolo 2001: 280). Isotropic analysis relates to instances where movement is independent of the direction of movement, for example, going up is considered as the same as going down a slope, though of course it considers other natural factors that can affect movement irrespective of the direction like vegetation cover, muddiness and the presence of wetlands. Anisotropic analysis is dependent on the direction of movement where it considers the difference between going uphill and downslope (Bell and Lock 2000; Herzog 2014). Topography in this study is seen as the main factor causing friction to movement. The need to have round trips is necessitated by the fact that fetching water requires a round trip to achieve the mission of bringing water to the occupation areas. The most demanding part of the round trip is when one is carrying the water.

### *6.4.1 Hill Complex – Least Cost Paths Supply of Water*

This section provides an analysis of the possible routes that could have been used to transport water to the Hill Complex. The point that was taken to represent the Hill Complex was located in the Western Enclosure. From the surveys undertaken, there is no evidence showing water sources or potential water sources in the Hill Complex. This leaves the valley as the source of water for the Hill Complex. As has been mentioned in previous chapters, sometimes there is a difference between where people fetch water for domestic drinking and where they fetch water for other uses. While water for drinking and cooking is usually fetched from protected wells and springs, water for other uses can be fetched from open wells, pools and dams (man-made or natural) which can also be used by

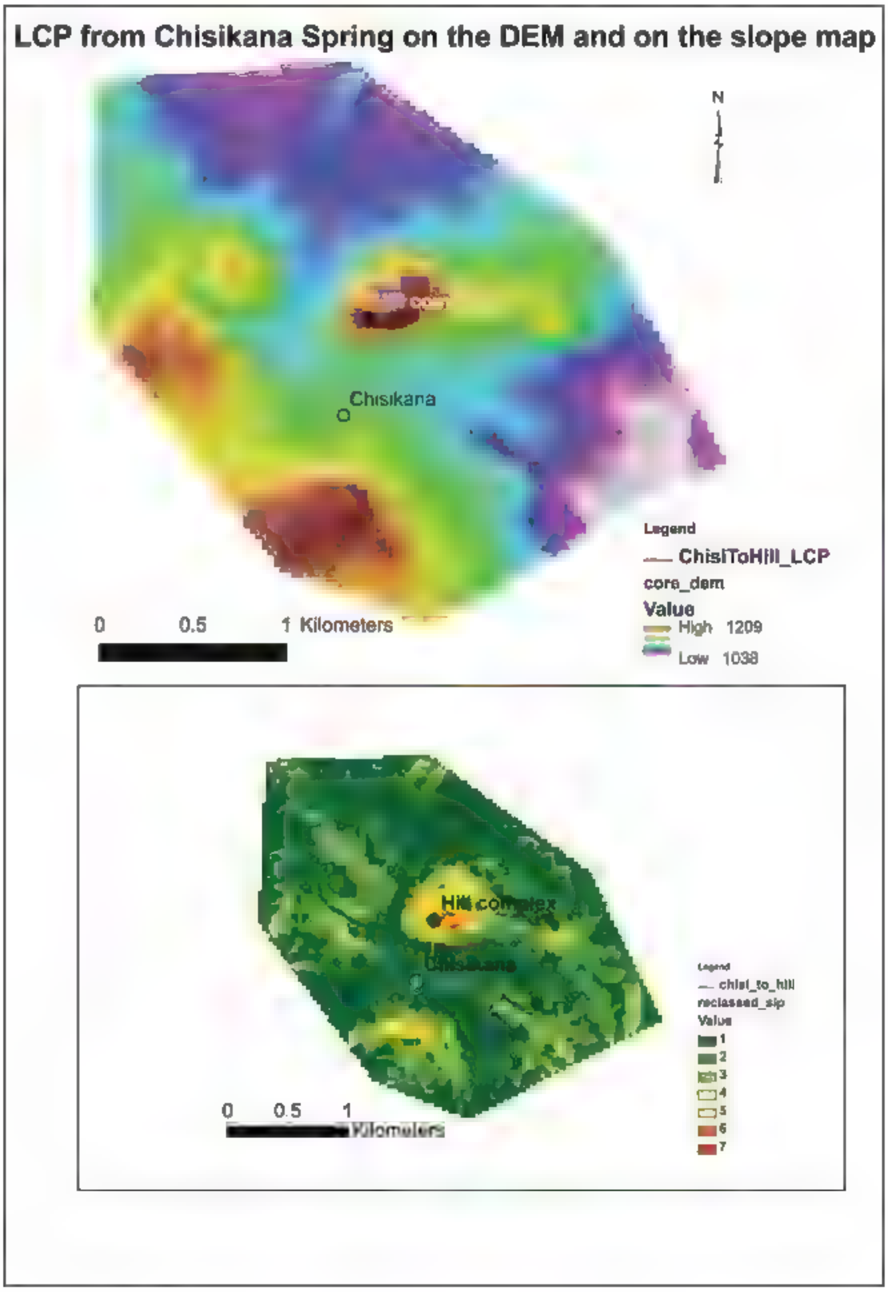



**Figure 74: The modelled Least Cost Path between the Hill Complex and the Chisikana spring.**

animals. Thus, if one is to assume that water for cooking or drinking within the Hill Complex was obtained from the Chisikana spring, then there is need to establish the routes taken by people to fetch water from this site. It would also be important to establish the energy required to walk or traverse each route. The production of the Least Cost Path followed the model builder illustrated in Figure 73, which was done in a ESRI ARCGIS programme

The Least Cost Path is the route that uses less effort from a point of origin to a destination. Spatial Analyst tool of ESRI ARCGIS produced a raster format route which was simply converted using the conversion tools of the ArcGIS toolbox The resultant LCP followed lower gradient slopes of between 0-6 degrees until it reached the edges of the Hill Complex where the gradient progressively changes from 6 to 26 degrees. The path, however, avoids the steep eastern sides which have a gradient of between 26 and 33 degrees. The Least Cost Path which avoids very steep gradient from Chisikana spring to Hill Complex measures 583m (Figure 74).

The modelled Least Cost Path was compared with known routes to the Hill Complex. These ancient paths are documented in early texts suggesting that they had been in use at least when early European explorers began to write about Great Zimbabwe. Describing the Hill Complex, Hall makes reference to the isolated nature of the hill as well as the high cliffs 'which render it inaccessible on three sides'. He also pointed out that the other areas where it could be accessed from had a steep gradient (Hall 1907: 23). This made some scholars like Mennel (1903) to speculate that the Hill Complex was meant to be a defensible place.

Hall (1907: 24) mentions two well-defined ancient approaches to the summit of the 'Acropolis', one being on the south side, presumably the Ancient Path, and the other one on the western side, presumably the Watergate Path. The existence of these paths is known since 1902 although for a long time they remained hidden since they were covered by falling stones (Hall 1907). In the absence of any water source within the Hill Complex, it is evident that the people who lived in that part of the city had to find means to transport water from springs, wells and other reservoirs at the bottom of the Hill Complex. The steps that characterise these paths show engineering skills required in traversing steep slopes

Considering that some known water sources are at the base of the Hill Complex, a cost surface analysis, in particular of the least cost paths, has been deployed to trace these known routes. Thus, besides the known routes uphill, alternatives are simulated, informed by water having been an important element needed in the settlement areas of Great Zimbabwe. The modelled path from the Chisikana spring to the Hill Complex is closely parallel to the known Ancient Path (Figure 75). There is a considerable overlap between the Least Cost Path and the known route It is less likely that the Ancient Path was used in the transportation of water uphill due to its restrictive nature

Hall (1907· 23) described the hill as a place that offered a natural stronghold and was 'artificially strengthened by massive rampant walls, traverses, screen walls, intricate entrances, narrow and labyrinthine passages, sunken thoroughfares, banquets, parapets and other devices of a people thoroughly conversant with military engineering

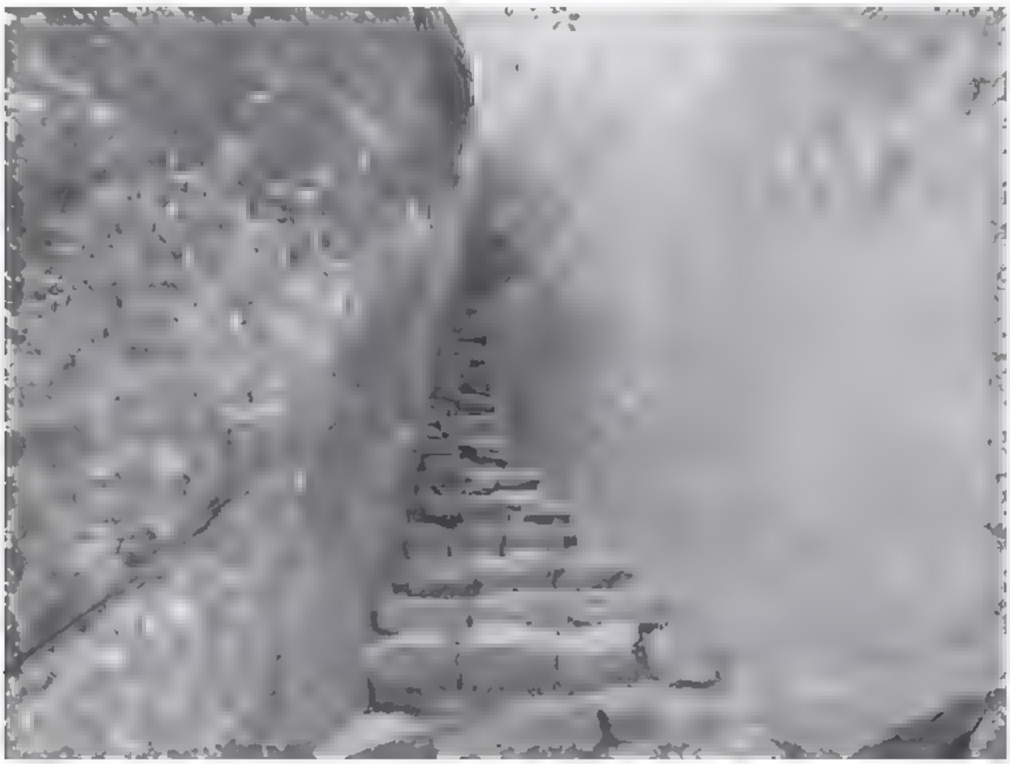


**Figure 75: Restrictive Ancient Path to the Hill Complex (photo by author).**

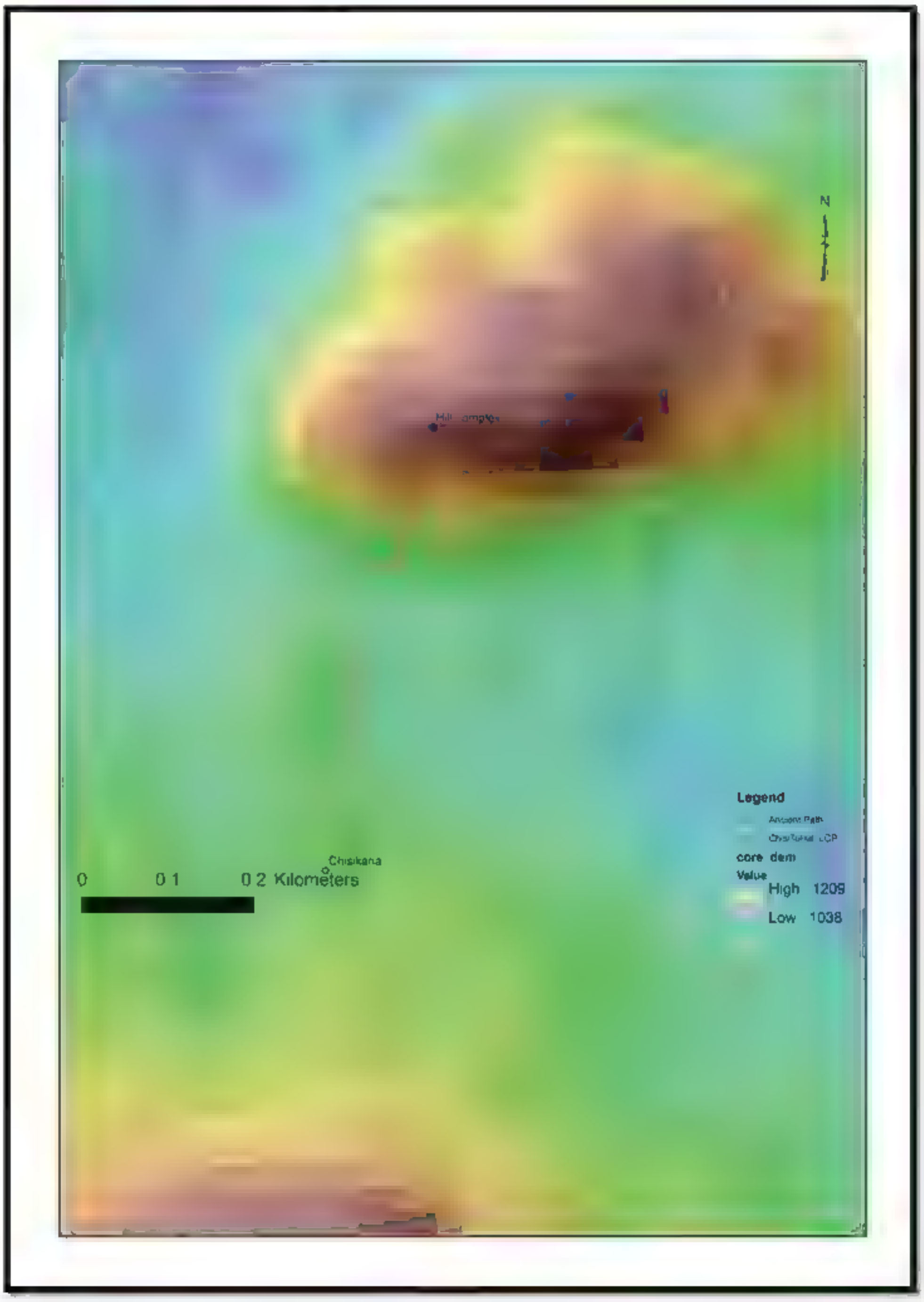



**Figure 76: Ancient Path against the simulated Least Cost Path to the Hill Complex.**

and defence'. It is thus unlikely that the Ancient Path was used as a route for the transportation of water uphill. A path using the least effort from Chisikana was therefore simulated (Figure 76).

Although it is possible that this route could have been used to transport water from sources below the hill, the fact that the path is steep and narrow makes it unlikely that it could have been used for that purpose. That leaves us with the Watergate Path as the most likely route that was used to transport water from various sources to the Hill Complex. The Watergate Path is the 'known' route to have been used to fetch water downhill for use in the Hill Complex. A number of potsherds that are found in this path, (Figure 77), together with the presence of a *dambo* at the bottom of the hill are evidence that it was used by people with these containers

Pavements as shown in Figure 78 are a characteristic of the Watergate Path. Pavements are done in most cases to drain away surface water Roinn (2015) argues that in built environments, scholars often overlook the surface, which is the one that holds historic structures in place. Thus, these pavements are a critical component in understanding the structures at Great Zimbabwe as they stabilise the ground, thus preventing erosion.

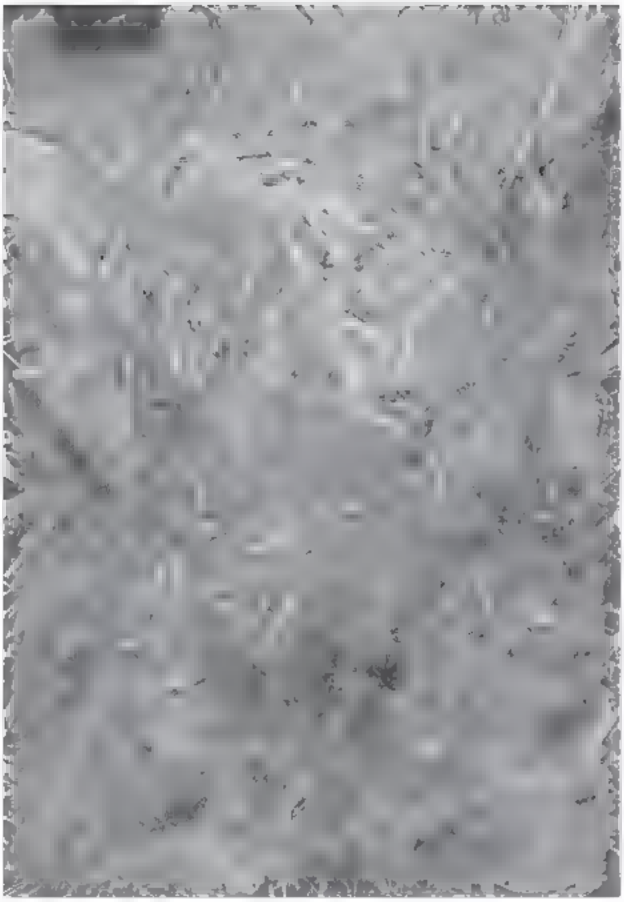


**Figure 77: Photo showing potsherds visible on the Watergate Path (photo by author)**

**Figure 78: Part of the Paved Watergate Path (photo by author)**

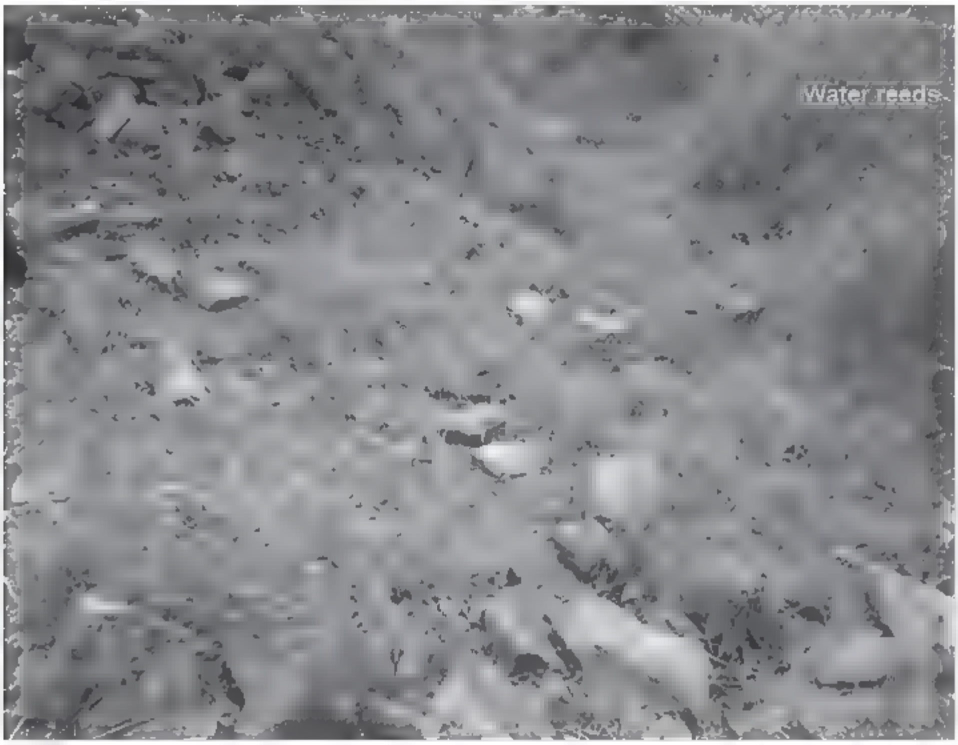



**Figure 79: One of the pits on the western side of the Hill Complex with reeds**

**Figure 80: Natural water hole in Daitai village (photo by author).**

Besides the Chisikana spring, the *dhaka pits* at the base of the Hill Complex are known ethnographically to have been water reservoirs.[1] It is unlikely that the water stored here was used for drinking. It is however probable that water from the *dhaka pits* could have been used for other domestic purposes. The pits contain reeds (*Phragmites australis*) which are associated with the presence of water reeds (Figure 79).

Water was evidently used in the Hill Complex. Apart from assuming that water was needed by residents in there, the *dhaka* structures, which include floors in the western enclosure, attest to the use of water. Bent (1895) and Hall (1905a) observed that gold processing and iron smelting were some of the activities which were conducted at the Hill Complex. All these activities required a lot of water which had to be ferried through the Watergate Path. As highlighted earlier, water for domestic purposes is generally accepted to have been transported using the Watergate Path. The known Watergate Path starts from the Watergate stone structure in the valley on the north-west side of the hill (Hall 1907: 25). Some of the areas along the path are quite steep. It is likely that the *dhaka* pits were some of the main sources of water. The idea of the *dhaka* pits as having been used as water reservoirs is strengthened by the sacred nature of Chisikana spring. The residents of Great Zimbabwe may have safeguarded this source through the creation of reservoirs which were supposed to receive

[1] Interview with Elder Makasva, 23 June 2015, Nemanwa Village

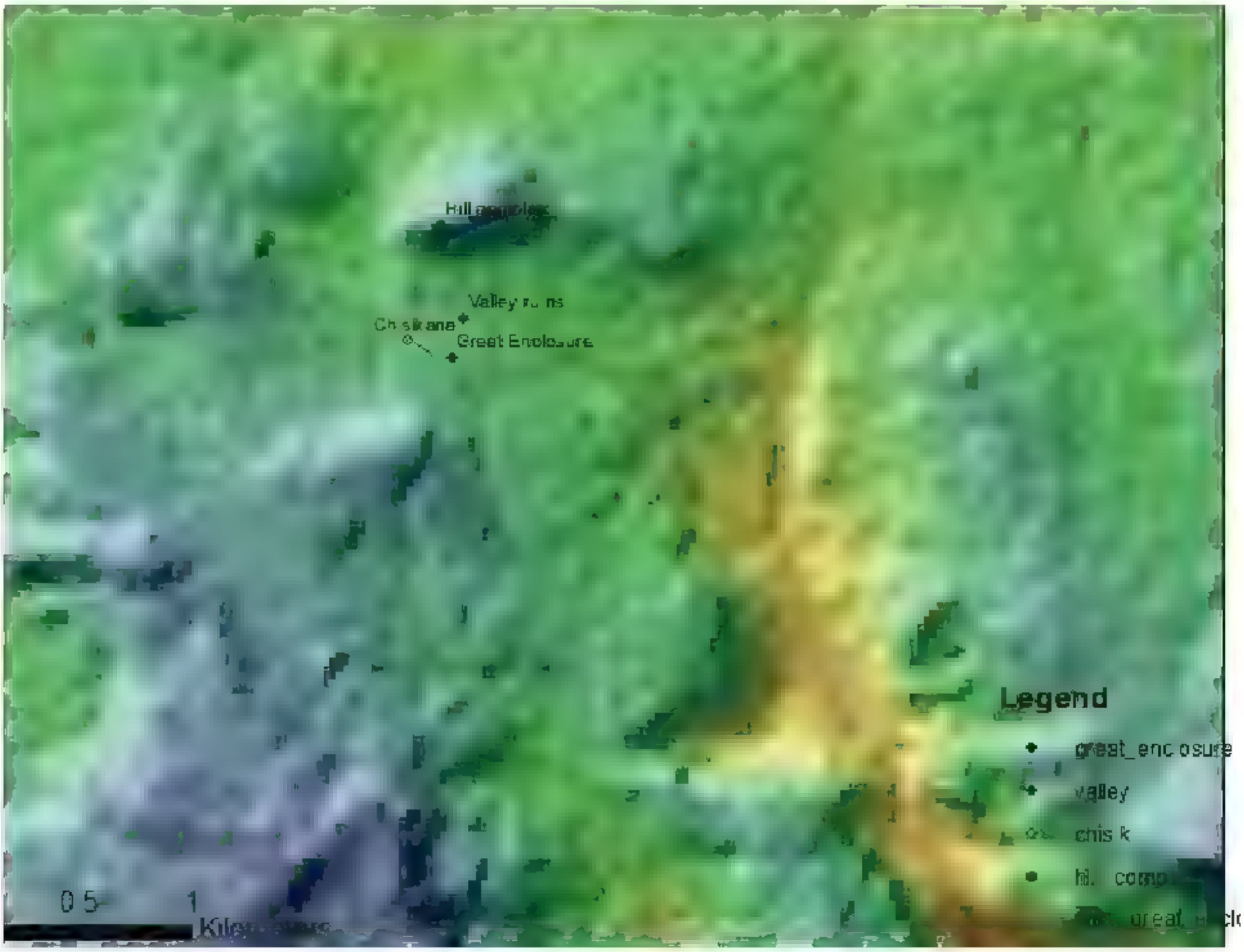



**Figure 81: LCP from Chisikana Spring to Great Enclosure**

water from it. This required considerable management, or at least digging such artificial pits to gather the water, and creating a broader facility in which town residents would access the resource Even water for the Great Enclosure may have been sourced from these pits as well as potential pits in the east of the Great Enclosure. However, there is a possibility that the stream running east in the gorge could have been dammed just after the Shona village for this very purpose

The presence of *dhaka pits* as significant water reservoirs for Great Zimbabwe raises the possibility of another route that could have been used to ferry water to the Hill Complex other than the Watergate Path It is therefore necessary to consider another possible path and to also do a least cost analysis

The modelled Least Cost Path measured 154m from one of the pits up to the western enclosure of the Hill Complex. The lack of overlap between the Watergate Path and the simulated Least Cost Path points to the idea that even though these pits could have been used as water reservoirs, water was not drawn from them directly. Rather, it is likely that some form of engineering was done so that water could be fetched at a point more direct to the entrance of the Watergate Path It can therefore be argued that there were a lot of water engineering techniques deployed in the water management at Great Zimbabwe. If water was fetched directly from the 'water reservoirs', the most effective route would have been the modelled LCP. The function of these pits as water reservoirs is strengthened by the offset location of these pits in relation to the drainage network. The location of these pits differs from natural pits that sometimes occur along river or stream channels Examples of such pits are found in Daitai village, east of Great Zimbabwe (Figure 80). There is little doubt that the Watergate Path was indeed used as a route for the transportation of water, and it is clear that the water could have been channelled from the reservoirs for the purposes of accessibility. The pits are deep and could have posed the danger of people drowning in them if they were to directly fetch water from them

### 6.4.2 Great Enclosure

The Least Cost Path (LCP) was simulated from the Chisikana Spring to the Great Enclosure (Figure 81)

The LCP from Chisikana Spring to Great Enclosure measures about 200 m. The LCP parallels the walled path which is characterised by the R walls which runs from the Great Enclosure up to almost where the museum is housed (Figure 82).

In the sequence of the walls, the R-walling was the last to be constructed (Whitty 1961). Assuming that the walled path, from the site museum to the Great Enclosure, was used as a route from water source to consumption areas,

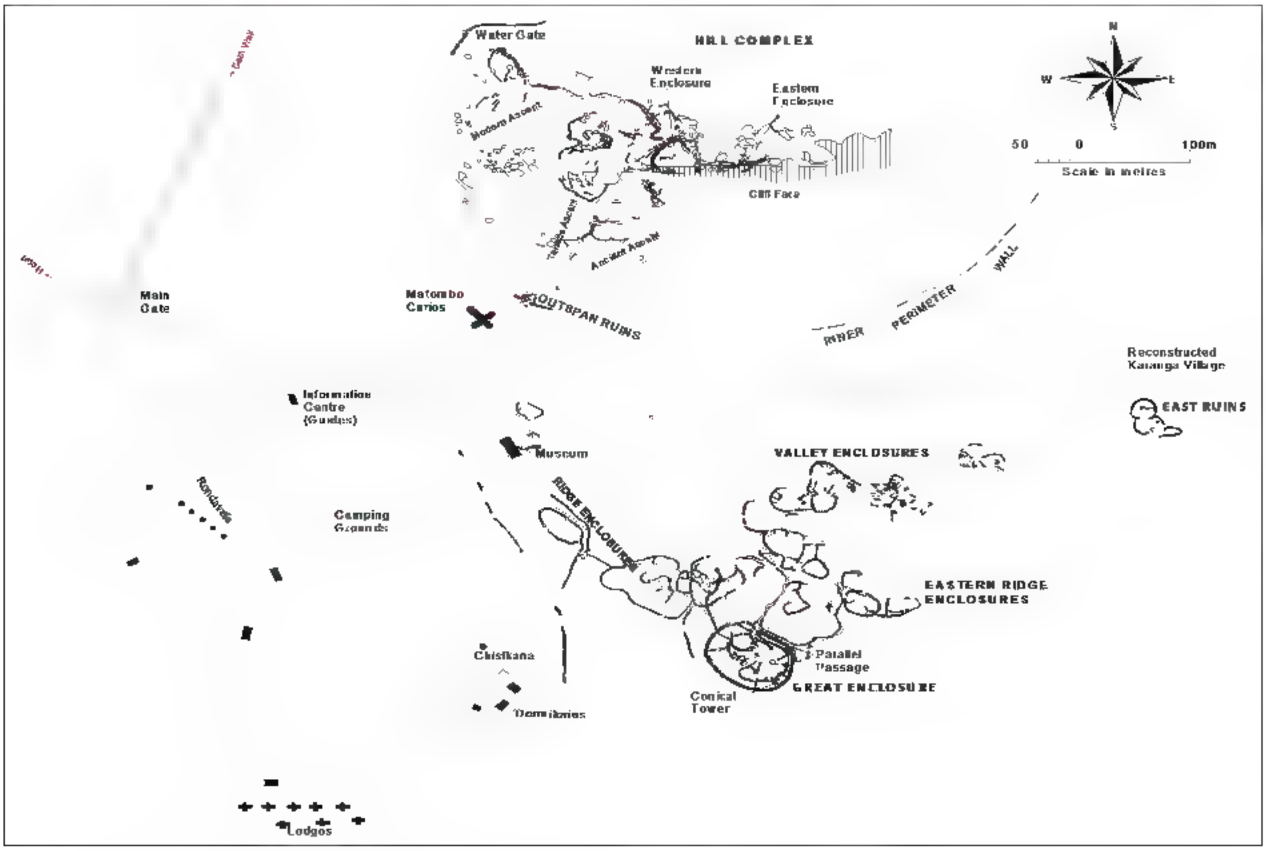



**Figure 82: Layout map of Great Zimbabwe showing the Ridge ruins.**

this closely resembles the Watergate Path which is also walled. It can then be argued that movement within the Great Zimbabwe ancient city was well ordered, including paths to get necessary resources such as water. In this case, it means that the R-walls may not necessarily have been constructed later than the other walls. They were simply a management tool regarding the regulation of access to various points of the site. The easy reach of the spring from the Great Enclosure makes it most probable that the occupants of the Great Enclosure obtained their water from it

### *6.4.4 Valley Ruins*

The Least Cost paths from the water sources to the Valley structures were also simulated. There are several structures in the valley mostly named after European visitors (Connah 1987) Among these are Maund (Eastern ridge), Phillips (Central valley), Posselt (Western Valley), Renders (Central Ridge) and Mauch (East Ruin) ruins There are others with conventional names like 'Ridge ruin', 'East ruin', 'Outspan ruin'.

For purposes of simulating LCP, the Western Valley ruin was taken to represent the occupation of the valley enclosures. The significance of this enclosure is, among others, the recovery of precious artefacts such as gold ornaments from it (Hall 1905a: 370) There are also mud (*dhaka*) floors within the enclosure such that at one point, a thatched hut was constructed to protect it from rainwater (Sinamai 2011). The thatched structure used to make the enclosure stand out of the other structures to an extent that visitors to the site were attracted to it. Thus a LCP from the enclosure to the nearest water source, Chisikana, was simulated

The LCP takes a north easterly direction before assuming a south easterly course towards the valley structures By avoiding the small hill which now houses the Great Zimbabwe Site Museum, the route goes through one of the pits on the southern edge of the Hill Complex. Thus, the LCP from the pits to the valley structures joins the one from Chisikana spring. It can be argued that the other pit on the southern side of the Hill Complex was meant to supply water to the valley structures and probably the Great Enclosure.

### 6.5 Water Transportation Routes and Implications on the Human Use of Space at the Ancient City

Water routes to the various built structures do not converge, and this suggests a form of human use of space where there was minimal contact between the Hill Complex, the valley residences and the Great Enclosure. For a long time, the built environment has been interpreted as one entity but if one considers the nature of water distribution, these built structures were separate entities. Movement through the landscape has been one of the areas that has received attention in archaeological research (Llobera 2000; Lock 2000; Leary 2014). In this regard, activities such as movement were taking place in some of the open spaces. There has been some debates concerning the open spaces, with some scholars arguing that the spaces were full of *dhaka* huts. This was evidenced by the recovery of several house floors at Great Zimbabwe. Huffman (1996a) for example, argues that the scattered house remains are evidence of a commoner settlement, an idea that has recently been questioned by scholars like Chirikure et al. (2016). In this case, it can be argued that in a city setup, some of the open spaces were intentionally left for purposes such as construction of houses It is also possible that the builders of Great Zimbabwe considered the importance of activities such as the ferrying of water to various areas of the city in constructing structures. Further, house construction during the Great Zimbabwe period must have factored in water routes

### 6.6 Conclusion

This chapter has demonstrated that water was of importance in the location and the architecture of Great Zimbabwe In particular, the provision of clean drinking water from the springs and other sources was of great importance. There are springs that are within the catchment of the built area of Great Zimbabwe which played a role in providing water for the ancient city as has been demonstrated from the catchment analysis of the various springs. Most of the least cost paths created in a GIS environment are close to the known routes. This suggests that the paths that characterise the ancient city of Great Zimbabwe also served to transport water from the various sources to consumption areas. Unlike many other resources, water is an absolute requirement on a daily basis. There is always a need to consider where and how to fetch the water for daily use. Consequently, an analysis of water sources and routes used to transport it to the built areas of Great Zimbabwe reveals both the centrality of water in the everyday lives of residents of Great Zimbabwe and its importance in space syntax

A host of other factors could have played a role in the determination of routes to fetch water. Besides terrain, there are other factors that affect movement such as the sacredness of places and these can be taken to account for the small diversions that we see in the least cost paths and the known routes from various water sources. The perception about movement is that the people who occupied Great Zimbabwe also considered least cost efforts in getting resources such as water to their various residences. The challenge with using Least Cost Analysis in tracing routes mainly centres on the lack of methodology to statistically test the validity of results, unlike in predictive modelling where results can be statistically verified by applying 'goodness of fit'. This leaves ground truthing as the sole method to test the validity of the results of the Least Cost Analysis which was done by getting into the field to check the modelled paths. Movement at Great Zimbabwe was thus influenced by gradient as well as the hydrological features at the site. The lack of or absence of a substantial built environment to the west may be a

product of regulation by these hydrological features or at least their consideration

The study, however, acknowledges that social factors could have affected patterns of movement at Great Zimbabwe but they are not accounted for here as a result of them being not visible in the archaeological record. The evidence in the form of broken potsherds shows how the people engineered the landscape and established the least possible paths which follow the known Watergate Path and other routes. It is quite evident that the large *dhaka* pits on the western edge of the Hill Complex were later used as water reservoirs. Besides serving the needs of the town's downhill populations, it can also be argued that these water reservoirs mainly served the water needs of the Hill Complex, with the broken potsherds along the Watergate Path attesting to this

The modelled least cost path follows the known Watergate Path. This indicates that the people living at the ancient city of Great Zimbabwe had engineering skills and were able to calculate the least possible path used to transport water to the Hill Complex. The path from Chisikana spring to the Great Enclosure almost resembles the walled path, thus highlighting control of movement within the site. For the Valley structures, the pit at the bottom, south of the Hill Complex, falls within the route that requires the least effort in moving from Chisikana spring This makes the pit the likely reservoir of water for the Valley structures. The chapter has mapped paths at Great Zimbabwe as a way of integrating movement at the site. The least cost path analysis has highlighted that the open spaces were not necessarily open and empty as activities such as movement were taking place in these. Thus, from a landscape perspective, space is taken holistically, including the monuments and empty spaces. The integration of these spaces shed light on how the site was lived rather than looking at it as an ancient city characterised only by stone walling. Water resources also shaped the settlement pattern as its availability at Great Zimbabwe must have had a significant contribution to the flourishing of this ancient city.

# 7

# Discussion and Conclusions

## 7.1 Introduction

This chapter discusses hydrological modelling and simulation of movement, assessing its reliability and implications. The chapter also examines water availability and management systems and discusses the same within the context of their impact on the demography of Great Zimbabwe and use of space. Conceptual and methodological approaches used in the study and their implications on our understanding of the archaeological phenomena at Great Zimbabwe, are discussed in this chapter. The chapter draws together and discusses the key findings and arguments made in this study. It also makes a case for the deployment of a space syntax approach in analysing the interface between water and space at Great Zimbabwe. The chapter discusses achievements and weakness of the research conducted and ends with comments on the future directions of studies of the site.

## 7.2 Water Availability

The people at Great Zimbabwe exploited both underground and surface water resources. The geology of Great Zimbabwe allows underground water to appear on the surface as springs. The existence of a number of springs around Great Zimbabwe suggests that they were some of the key sources of drinking water. In addition to the springs, the seasonal rainfall contributed to surface run-off in the form of streams and rivers, which formed part of the water sources at Great Zimbabwe.

Great Zimbabwe receives seasonal rainfall whose surface run-off feeds into streams. The seasonal nature of the rainfall makes most of the streams around Great Zimbabwe ephemeral in nature. Great Zimbabwe had wetter seasons which could supply the settlement with enough water for long periods of time. Great Zimbabwe's micro-climate, which is characterised by drizzle *(guti)*, is an important factor in the availability of water.

Hydrological modelling of the study area has highlighted that the amount of moisture in the area around Great Zimbabwe makes the place suitable for habitation as well as for sustaining the economic base of the people who resided there. The availability of water in the form of springs and *dambos* is capable of supporting an economy based on cultivation of crops and domestic animals. Using the availability of fertile soils and well-watered environments, scholars such as Garlake (1970, 1973) and Pikirayi (1993, 2001) have argued that the inhabitants of Great Zimbabwe were farmers. As demonstrated by Wills and Dorshow (2012), the availability of fertile soils and moisture was one of the key considerations in settlement location. Using the case of the Chaco Canyon, Wills and Dorshow (2012) emphasise the paramount nature of the availability of moisture together with other variables in considering areas suitable for cultivation. Thus, water is of paramount importance in sustaining a society based on farming like Great Zimbabwe. Hydrologic modelling is one of the most useful tools in analysing water availability and suitability of a settlement for human habitation and agriculture. Results of hydrological modelling have shown that Great Zimbabwe is a well-watered area. The Topographic Wetness Index (TWI), for example, indicates that Great Zimbabwe's catchment area has abundant water

It is probable therefore that one of the reasons why the city was established at Great Zimbabwe is that it was well-watered. However, it is also important to note that these environmental conditions could have changed as evidenced by the models coming from precipitation and temperature data which show climatic changes over the past 50 years The watershed conditions in the hinterland possibly had an impact on the water supplies to the ancient city. From recent data, it is evident that the changes in precipitation and temperature could have affected the environment leading to the collapse of the city State collapse here is taken in Tainter (1988)'s sense of viewing it as a political process which impacts the socio-economic activities of a society. According to Tainter (1988), a society is said to have collapsed when it displays a rapid decrease in the level of socio-political complexity over a period of two decades

### *Underground Water*

Besides surface water, Great Zimbabwe's population obtained underground water from springs The nature of the geomorphology of the area, which is characterised by gneiss, allows underground water to come up through vents as springs. From ethno-historical accounts, these springs are known to have provided a considerable amount of water, which makes them a possible factor on the choice of location and the development of Great Zimbabwe as a city. It is, therefore, not only rainwater that is considered a valuable resource for the city but also underground water Granite cracks provide natural channels through which water flows from underground to emerge on the surface as surface springs and aquifers Thus, the cracks on the rocks provide good reservoirs for drinking water (Herbert et al. 1991).

In the area around Great Zimbabwe, springs are an important part of traditional water supply. It can be argued

that even during the time of occupation, springs were an important source of water for the inhabitants of the ancient city. There are indeed a number of springs, extinct and active, in the environs of Great Zimbabwe. Chief among these water sources is Chisikana spring situated within the area designated a national monument Although it is no longer running, Chisikana spring used to be a significant source of water for Great Zimbabwe (Hall and Neal 1904; Hall 1905a). It was probably the main water source for the built up area of Great Zimbabwe. Water from the springs would also add to the surface run-off following natural channels that would drain the rain water into streams like Chisikana which used to flow from Chisikana spring and drained into Shagashe River. The Chisikana stream is an example of streams that are fed by both surface runoff and underground water. Although Chisikana was arguably central in the provision of drinking water for the inhabitants of Great Zimbabwe, ethnographic evidence suggests that water was not drawn directly from there because it was considered sacred. Thus, it is probable that the pits found within the Great Zimbabwe site were meant to harvest not only rain water but also water which was being drained from these springs. The *dhaka* pits, are therefore, evidence of the water engineering exhibited at Great Zimbabwe.

### 7.3 Water Management at Great Zimbabwe

Ethnographic data points to the fact that the residents of Great Zimbabwe used a number of water management systems. The study incorporates oral accounts in interpreting archaeological phenomena. Using the ethnographic present, it can be argued that there has always been a way of managing water, be it surface run-off or underground water, at Great Zimbabwe. The management strategy depended on the nature of the water and the function it served. Although there are many sources of water, water for drinking and other domestic uses was usually drawn from springs or well-maintained wells. These water sources required specific management strategies. However, there are some strategies which cut across most of the water sources. These include management through honouring the sacredness of water.[1] From an African perspective, all water sources are sacred (Altman 2002), hence there are taboos that are used to maintain the sacredness of the water Taboos are meant to keep water sources in a pristine condition, thereby maintaining hygiene. Tatira (2000) argues that taboos (*zviera*) were part of the strategies that were put in place to ensure development through cleanliness Tatira (2000: 148) cited one of the taboos that encouraged the cleanliness of water sources; 'if you urinate in water you will fail to conceive'. In this case, springs and other water sources were protected from contamination. These taboos were put in place to dissuade people from desecrating the water sources Those who disregarded these taboos were punished by water spirits (*njuzu*). An example is the case of the legend of someone who tried to fetch water from Burutsa Spring, located a few kilometers away from Nemanwa Growth Point, whose clay pot mysteriously disappeared only to reappear the following morning.[2]

Water management systems in the observed ethnographic present arguably have resonances with past water management systems. Examples of such include taboos associated with sacred water sources There are also myths surrounding water spirits appearing at sacred springs as mermaids which punish or suddenly take away offenders Therefore, African cosmology also helped in the protection of water sources. Hughes and Thirgood (1998) argue that in Ancient Greece and Rome, just like many traditional societies, taboos were used as a control mechanism to protect water sources Similarly, Bernard (2003) argues that among societies in southern Africa, most water sources were and are still considered to be sacred. A range of taboos are, therefore, put in place to govern water utilisation and its access. Nemarundwe and Kozanayi (2003) assert that most of the governing rules relating to water use are not written down. With regard to drinking water in Zimbabwe, these taboos are meant to ensure cleanliness around water sources (Nemarundwe and Kozanayi 2003). Some of the taboos prohibit washing of clothes next to a well or spring as well as fetching water using containers with soot (previously used for cooking). In the case of rural Ghana, Gyampoh et al (2009) observed that taboos were very effective in controlling human behaviour around various water bodies. With the coming of modernisation and to some extent Christianity, these taboos have been shunned leading to the desecration and subsequent drying of these water bodies.

The springs around Great Zimbabwe are managed by some taboos which were put in place to regulate the fetching of water The continued existence of the water related taboos in the ethnographic present could be used to argue that these taboos were in place during the period when Great Zimbabwe was flourishing. With particular reference to the Huacas of the Wari Landscape in Peru, South America, Glowacki and Malpas (2003) argue that religious myths are some of the most common water management and control mechanisms. Taboos have a religious basis. Glowacki and Malpas (2003), argue that religious ideology is the least likely component of culture to change over time. Thus the presence of religious taboos and myths in management of springs around Great Zimbabwe can be traced back to the ancient times

Water related processes could have played a role in shaping the patterns exhibited at Great Zimbabwe. It can be argued that some of the built structures were constructed with the need to control the flow of water in mind. The argument presented here is that, in as much as water dictated where people settled, the degree of proximity and access was affected by other natural and cultural factors. Taboos and other physical management strategies enabled the

[1] Interview with Rev Nkomo, Morgenster Mission, 20 June 2016

[2] Interview with Mrs Muzhanye and Elder Mayaya, Muzvimwe Village, 15 July 2015

sustainability of the water sources since they regulated the use of the water resources.

Apart from domestic use, water is also a critical resource for domestic animals. There are specific water management strategies that are used for sources of water for domestic animals. It was also observed during fieldwork that the damming of flowing rivers was done in some instances to create water reservoirs Water sources could be fenced off using thorns. Hence, physical barriers were constructed not only to protect the water source from animals, but also to make sure that the water sources did not pose a danger of drowning to the animals. Against this background, it can be argued that it is possible the perimeter walls stretching from the North-West to the South-West of Great Zimbabwe's Hill Complex were possibly meant to protect water sources especially given the fact that they follow water channels or the direction of flow Although orthodox archaeological interpretations of Great Zimbabwe suggest that the outer and inner perimeter walls marked the boundary between the Hill Complex elite and the commoners living in the valley there are reasonable grounds to assert that these walls were possibly used to protect water sources

*Water Engineering*

As cities grow, there is usually a corresponding increase in the demand for water. Hence, people had to develop strategies of managing and distributing the available water. As argued by Lavento (2010), societies usually use a number of innovative methods of utilising their environments and dealing with challenges they may pose. Unlike the conditions offered by other civilisations like Petra of Jordan where people had to deal with small amounts of water (Wright 2006), the models for Great Zimbabwe have indicated that the city was well watered Great Zimbabwe had comparably better water sources and climatic conditions that ensured the availability of water for much of the year. Ancient cities such as Petra were located in a desert environment and required a careful management of limited water resources (Wright 2006; Lavento2010) In such environments, technological methods are used in the storage of limited water which usually comes as flash floods for a few days in a year Lavento (2010) highlights the importance of water collection and distribution systems. Evidence of such in the archaeological record includes cisterns and open pools which were used as water reservoirs These cisterns are very visible at Petra as they were quarried in the sandstone or limestone bedrock. At Great Zimbabwe, instead, the preservation of archaeological evidence for water engineering may be compromised by the local geology

There is apparent subdued visibility of water engineering works such as cisterns, canals and pipes, comparable to that of ancient cities like the Maya (Scarborough 2003, 2014; Scarborough et al. 2012), Jordan (Mithen 2010; Wåhlin 1997), Machu Pichu (Wright 2006) and in the eastern highlands of Zimbabwe (Soper 1996a, 2002, 1996b; Kusimba and Kusimba in press). In spite of that, there is evidence which reveals significant efforts by residents to contain, control and channel water. The inhabitants of Great Zimbabwe employed some engineering skills in channelling water from sources *to dhaka* pits There is also evidence in the form of a marsh (*dambo*), west and downhill of the Hill Complex, suggesting that the residents of Great Zimbabwe made an effort to manage water. The process of channelling water to the pits could have led to the development of the *dambo*. The perimeter walls could also have been constructed to control flowing water and also control access to the water. Drain holes suggest that the people at Great Zimbabwe had knowledge of the need to allow water to flow out of the built environment without causing damages to the walls. Early work at Great Zimbabwe such as the Masey (1911)'s report observed water engineering at Great Zimbabwe in the form of drains which are a feature at the base of the gigantic stone walls This indicates that the residents of Great Zimbabwe were fully aware of the effects of water. In this regard, preparedness to deal with flood water is evidenced by these holes The drain holes are thus an indication of water engineering skills exhibited by the people of Great Zimbabwe. In addition, the terraces on the south western slope of the Hill Complex also attest to engineering skills of managing slope, mainly with the impacts of rainwater in mind The evidence provided in the study shows that water engineering was part of Great Zimbabwe, in spite of the absence of spectacular features.

It should also be highlighted that settlements which have shown evidence of extensive water engineering have particular geological formations. Research has shown that limestone and sandstone geological formations allow for the construction of cisterns for collecting water. Such cisterns have been observable in Petra's archaeological record In the case of Great Zimbabwe, water collecting pits are in loam soil, a formation suitable for subsurface water collection. The water engineering systems at Great Zimbabwe are therefore closely related to the geological base of the area. Although these pits do not easily show workmanship in their execution, they are substantial features in Great Zimbabwe's landscape

The Great Zimbabwe catchment is characterised by rivers and streams of various sizes. The ethnographic data collected record that although water can be accessed from rivers, rarely is it used for drinking or cooking Some engineering works were required to draw water outside the river channels. The system of collecting water with cisterns and temporary reservoirs was an effective way of managing water for domestic use. The ephemeral nature of the streams around Great Zimbabwe necessitated the need to institute water management systems. The underlying rock and the soil formation allow for such innovations. Hence the *dhaka* pits were arguably used as water reservoirs The close resemblance of the pits to the traditional wells in terms of their location makes it likely that they served the same purpose. The argument is also supported by the location of traditional wells found in

the study area. Water wells are dug some distance from river channels and, considering the location of the pits in relation to water channels, it is probable that the pits served the function that wells serve.

The *dhaka* pits are of various sizes which can thus be attributed to the nature of the drainage basin as well as the size of the population. It was also highlighted from the ethnographic survey that the size of a well is determined by the population that it serves. It is therefore possible to estimate the population of Great Zimbabwe using the number and size of water reservoirs at this ancient city. In total, there are seventeen (17) *dhaka* pits at Great Zimbabwe suggesting that the population was quite substantial during the occupation period of Great Zimbabwe. However, as argued by Chamberlain (2006: 4), demography is a very challenging phenomenon to deal with in archaeology especially when one tries to infer population sizes using material recovered from a site.

Ethnographic and archaeological research point to the fact that the *dhaka* pits were water reservoirs and they collected both surface run-off and water drained from Chisikana spring. Early observers such as Hall (1905a) highlighted the fact that these pits were not natural but were man-made, which supports the view that they were part of water engineering innovations by the inhabitants of the city. The location of the pits also has resonances with the ethnographic record which shows that water is not fetched directly from the springs but from wells dug down stream. The fact that the *dhaka* pits are not located directly in water channels demonstrates a conscious and deliberate human decision which shows water engineering skills. If the pits were located too close to water channels they would easily be damaged by water currents and it would be difficult to manage overflows. The solution was therefore to divert water to the pits dug some distance from the water channel. The location of the pits slightly outside the water channels is therefore an indicator of a deliberate move to divert water to these pits for storage purposes. This shows that the people at the ancient city were able to manage water, considering that rainfall in this area is seasonal. The seasonality of rainfall and the need for reservoirs is well demonstrated in the case of the Maya civilisation. Lucero et al. (2014) argue that the engineered features of the Maya landscape such as cisterns were a way of balancing the seasonal fluctuations of water. The water reservoirs were critical in areas without perennial surface water, a situation which relates well to the Great Zimbabwe environment.

The presence of water reservoirs at Great Zimbabwe challenges claims by scholars such as Gumbo et al. (2012) who argue for the non-existence of traditional water harvesting systems in Zimbabwe. Gumbo et al. (2012) argue that it was only the recent recurrent droughts especially between 1959 and 2001 that led people to realise the importance of water harvesting through construction of water reservoirs. However, as possibly suggested by the case of Great Zimbabwe, water harvesting and construction of water reservoirs are not recent phenomena. The pits downstream of Chisikana spring as well as those on the bottom of the Hill Complex were strategically positioned to collect water from the spring. The absence of similar features within the confines of Great Zimbabwe and its surroundings makes it less likely that they could have been sources of clay used in the construction of pole and *dhaka* houses. These pits are only concentrated adjacent to the built up area of Great Zimbabwe which makes it highly likely that they were strategic water reservoirs supplying the water needs of the city. However, the depth of the pits makes it very unlikely that people fetched water directly from them; rather, there seem to be some shallower channels where water could be safely fetched.

One of the features at Great Zimbabwe are the drain holes on the base of some of the walls. The fact that these holes are located at the base of the walls suggests that they were not an afterthought but were part of the engineering of the stone walls from the beginning. The holes were an architectural innovation designed to control water flow within the walls and to protect the walls from water. Their occurrence suggests that even during the construction of the walls, surface runoff was in abundance and as such, needed control. The abundance of the resource at Great Zimbabwe is also evidenced by the terraced walls of the south western side of the Hill Complex which arguably have received very little scholarly attention. A notable way of managing water and slope was through the buttressing of some slopes into terraces. Archaeologists who have done research at Great Zimbabwe have tended to focus largely on the magnificent free standing walls. However, one phenomenon that has escaped the attention of scholars is the presence of terraced walls on the south western side of the Hill Complex. Most of the terraces were most likely used for slope and water management. Although most of the terraces have collapsed, the term 'Terrace Path' which is used to refer to the path from the south leading into the Hill Complex points to the existence of these once spectacular terraces. Recent archaeological research at Great Zimbabwe by Chirikure et al. (2016) has suggested remapping of features of the site, including the terraces. Against this background, the study has highlighted the need to go beyond documenting to assess function within the broader Great Zimbabwe landscape.

Archaeologists have identified two major uses of terraces in Zimbabwe's archaeological record. There are terraces that were used to retain soils for agricultural purposes such as those identified at the Nyanga terrace complex (see Summers 1958; Soper 1996b, 2002; Kusimba and Kusimba *in press*). There are also terraces which served as house platforms, like the ones at Khami ruins. Given the close association between Khami and Great Zimbabwe, it is probable that the terraces at Great Zimbabwe's Hill Complex may have been constructed so as to create platforms on which houses were built. In both cases, one of the purposes served by terraces was that of managing slopes and drainage. The terraces at Great Zimbabwe are an indicator of water and slope management. Available

archaeological evidence largely point to the fact that there were some forms of water engineering and water management systems at ancient sites such as Great Zimbabwe, Khami and Nyanga This undoubtedly shows the salience of water in the growth and development of ancient civilisation and also its contribution to the demise of the same

Engineering skills were also exhibited in how the people traversed the landscape particularly in the process of fetching water. According to Bell and Lock (2000), movement is an integral part of being in a place Departure and arrival at a given place are central factors in understanding the sequential spatial narrative. The location of the Watergate Path in relation to the water sources suggests that the path was indeed used for fetching water. In addition, the potsherds recovered along the path are those of pots which were traditionally used for fetching water. Even at present, potsherds can be seen on the Watergate Path. It is possible that some of the clay pots that were used to fetch water broke on the way to or from water source. The close relationship between the Least Cost Path and the Watergate Path also confirms water was transported from the pits to the west of the Hill Complex uphill through the Watergate Path. The use of a path that uses least effort gives insights on the inhabitants of Great Zimbabwe's perceptions of the effort needed to ferry water to places of habitation. The residents of Great Zimbabwe were very conscious of how they could traverse their landscape In case of very steep slopes, the residents again found a way of making the hills accessible. The steps or platforms on the Watergate Path attest to this

However, in simulating Least Cost Paths, the resolution and accuracy of the elevation data are critical indices that can affect results. Elevation data plays an important role in least cost path analysis and this depends on the topographical area being studied. The results of the analysis show the significance of water in social processes like movement at Great Zimbabwe Thus, from simulating movement based on topographic settings, it can be argued that the paths leading to the various areas of the Great Zimbabwe were a necessity from early times as some of them were used in the fetching of water from the various water sources. The Watergate Path and the Least Cost modelled path indicate that the pits to the western side of the Hill Complex were in fact, water reservoirs which supplied water to the Hill Complex. The people at Great Zimbabwe had developed a method for coordinating the movement of water.

### 7.4 Water Resources and Demography at Great Zimbabwe

Currently Great Zimbabwe's surrounding settlements which include Nemanwa Growth Point and Morgenster Mission have a population of close to 20 000. However, this is supported by an extensive modern water reticulation system which gets very strained during the dry season leading to water rationing This casts doubt on the possibility of Great Zimbabwe's population having been at any moment as high as the suggested 20 000. What can be argued, however, is that a large percentage of Great Zimbabwe's population was composed of visitors and not permanent inhabitants of the settlement. Large volumes of traffic would have visited the site for day activities such as rituals, ceremonies and trade among others. This resonates with the concept of periodic markets which was suggested by Scarborough (2003) in the case of the Maya These periodic markets are found in centralised societies Evidence of such markets includes different ceramic wares associated with different communities, a situation which can be identified at Great Zimbabwe.

There is no water source in the Hill Complex which means that this part of the settlement got its water from below the hill In spite of serving such an important function, it has been observed that there are no known water sources in the Hill Complex. This suggests that only a few people were residing in the Hill Complex, with the majority only visiting on a daily basis to carry out activities such as rituals This also has a bearing on the estimated number of people who are believed to have occupied the site during its peak (Garlake 1973; Huffman 1996a; Beach 1998) This also suggests that the Hill Complex was meant for religious and political functions The discovery of the soapstone birds within the Hill Complex also suggests that it was used for ritual activities (Matenga 2011). Politically, elevated areas such as hills have been argued to be associated with rulers (Huffman 1981)

The absence of a known water sources in the Hill Complex, the seat of power, makes a departure from other known civilisations such as MachuPicchu where access to water sources played a role in shaping the socio-political status of the system. The Machu Picchu Mountain has a fountain which provides very clean water whose access was regulated by the elite (Wright 2006). Having reconsidered the economic models at Great Zimbabwe, the study highlights that the importance of local economies in the form of water resources should not be underestimated in the emergence, establishment as well as the ultimate collapse of the ancient city

In spite of the above, there were a number of people who were permanently residing at Great Zimbabwe and therefore required a reliable supply of water. The carrying capacity of the Great Zimbabwe should also be viewed within the context of the distribution of water sources around the area. For ancient civilisations, many cities were built in locations that could not support the populations that developed, hence the need to maximise water resources resulted in some engineering work being done. However, there is need for a holistic approach in understanding the centrality of water and its engineering in ancient cities. Scarborough (2003) argues that it is possible for populations to overshoot their resource base. Roudi-Fahimi (2001) argues that in the case of the Middle East and North Africa, rapid population growth exacerbated the water scarcity. Once water is available for human

use, however, many factors affect how that water is used Population growth usually increases demand for water in all sectors of the economy: agricultural, industrial, and domestic. Scarborough (2003) argues that there is need to deconstruct the determinism of human ecology. This is the notion that human society impacts and is impacted on by the environment based on the same suite of physical forces that dictate changes in the natural world. Although the biophysical environment remains fundamental, its importance should be understood in the context of culture (Scarborough, 2003). In this regard, Scarborough (2003) makes reference to enduring complex societies that are especially creative in engineering the landscape to accommodate their developing material needs As the population grew, Great Zimbabwe residents found ways of accommodating the growing city by making use of pits as reservoirs.

From ethno-historical accounts, it can be argued that there was local production of crops to cater for the families and communities living within the Great Zimbabwe area Water for small-scale agricultural production was obtained from the rivers (mostly ephemeral) within the micro-catchments of Great Zimbabwe. Chirikure et al. (2016) question the elite versus the commoner interpretation of the use of space at Great Zimbabwe. In this discourse, the elite occupied the walled enclosures while the commoners occupied the 'open spaces'. A holistic approach dictates that Great Zimbabwe be viewed as a landscape comprising the built environment and the open spaces. Both areas should not be viewed as separate entities (Chirikure et al 2016). It is argued in this book that the open spaces are not 'empty' as several activities took place in them. People traversed these spaces ferrying water, firewood and food among other activities.

The use of material culture to estimate population size is one of the issues archaeologists researching on ancient cities have debated for a long time. According to Chamberlain (2006: 4), there is no quick and easy route by which population size and structure can be inferred from analysing material culture and organic evidence of past environments Thus, the deployment of GIS tools such as applications for catchment analysis would yield useful information. In particular, Voronoi polygons or Cost Surface Analysis could be used in understanding the demography of Great Zimbabwe. It should, however, be appreciated that using resources as a measure of population size has its own limitations. Scarborough (2003) argues that dense populations are not an explanation for the overexploitation of an environment. He argues that in most cases, enduring complex societies are especially creative over the *longue duree* in engineering landscapes that accommodate their developing material needs (Scarborough 2003· 4367). He further argues that although populations can overshoot their resource base, societal collapse is seldom explained in such simple terms. It is, therefore, important to consider the impact of structured activities on the landscape that sustained and maintained the economy. Water access is one of the elements that ensure sustainability (Scarborough et al. 2012). Using various GIS tools to explore and determine known and potential water sources as well as patterns of exploitation, this study has cast doubt on the population size suggested by early scholars.

The catchment analysis done through the creation of cost surfaces focusing on water resources around Great Zimbabwe yielded results which suggest that the population size which early scholars had suggested was way too high to be supported by the available water resources. However, catchment analysis alone cannot make conclusive results There is therefore need for a more systematic research on the water budget of the Great Zimbabwe landscape. This will involve a quantitative study of the yield of various water sources

**7.5 GIS Tools and Great Zimbabwe's Water**

This study used GIS tools, particularly models, to understand social processes at Great Zimbabwe. The use of models in archaeology is unavoidable since the past is complex, often unknowable and unverifiable. Thus, working through models is the only way of approaching explanation and experimenting with the meaning of observed data (Lock, 2003: 149). Lock and Pouncett (2009· 192) emphasised the 'push button' functionality of GIS-based visibility studies and Cost Surface Analysis as tools that have led to the proliferation of studies linked to these The models produced in GIS have confirmed known routes at Great Zimbabwe, and alternative routes have also been established. The interconnectedness between various locations within the site can now be understood through network analysis. Through network analysis, showing the communities interaction with water resources, the use of the *dhaka* pits as water reservoirs was confirmed. It can thus be argued that the pits are evidence of water engineering features within the Great Zimbabwe landscape This study therefore casts doubt on earlier claims that the large pits were a source of the clay that was used in the construction of earthen structures in the ancient city The use of these pits as water reservoirs is not peculiar to Great Zimbabwe. Elsewhere, like in the case of Maya (Scarborough 1998), there was widespread use of artificially altered as well as natural depressions as water reservoirs Weiss-Krejci and Sabbas (2002), who excavated some of the features which have been considered to be cisterns in the case of Maya, observed that initially, they were natural sinkholes or quarry where materials for construction were obtained It is possible that the pits at Great Zimbabwe were initially construction 'features' where *dhaka*(clay) for building was sourced Overtime, the function changed with the city growing and having to meet the water needs of the increased population.

The primacy of water has made scholars such as Wittfogel (1959) argue that some of the ancient civilisations were brought about by unequal access to this resource, a theory that is known as the hydraulic theory Citing Wittfogel theory of 'hydraulic civilisation', Stile (1996) argues that water, as with energy, is a critical resource and lends itself

to the imposition of control and authority. However, the main source of water for cultivation in the Great Zimbabwe landscape is rain water, which is seasonal, hence the need for water reservoirs The sheer size of Great Zimbabwe makes it improbable that it could have been run without any water management systems. The absence of sound water management systems in place could have led to an early demise of the city.

The methods that have been used in the study have contributed towards understanding the social formation of Great Zimbabwe as well as processes such as movement and how it was controlled by water needs at Great Zimbabwe. Thus, the study also responds to recent calls for archaeologists to reconsider the importance of oral accounts in the interpretation of archaeological phenomena, particularly in Africa. From an Africanist perspective, it has been argued that the written word cannot be separated from the oral texts (Pikirayi 2015: 536; Vansina 1985). In understanding water resources around Great Zimbabwe, the study has combined an analysis of the physical remains associated with water use with an examination of the geographical base where processes are taking place

### 7.6 Limitations

Although the study managed to use a number of methodologies to model cultural and natural processes, there were also a number of challenges that were faced Some of them include the fact that there was a limited number of weather stations The research used data from only two weather stations, Masvingo Town and Great Zimbabwe Monument. This meant that only a limited analysis of rainfall patterns could be done In spite of this challenge, the available data was useful in capturing rainfall and temperature variability. The other challenge concerns the unavailability of dates for the *dhaka* pits and other water features Dating of water features will help in determining the chronology of water management at Great Zimbabwe. The study, however, shows that the use of ethnographic data, historical accounts and local traditions aided by GIS tools can go a long way in providing a timeframe for past water management such as at Great Zimbabwe.

### 7.7 Conclusion

Although Great Zimbabwe has received considerable scholarly attention from historians, anthropologists and archaeologists among others, there has been very little attention paid to the centrality of water in everyday lives of the settlement's inhabitants. More importantly, scholars have paid cursory attention to water especially sources of water for the city, water engineering and water management systems. Yet water has proved to be a critical resource in the sustenance of great ancient cities (Scarborough et al 2012). The availability of clean water has a bearing on the population levels of a city and assumes even greater importance in times of strife, especially during droughts and wars. This study has established that water was one of the key strategic resources at Great Zimbabwe which was probably as important as gold and iron. As a resource, water was critical in the everyday lives of the people who lived within the city and those who visited it. The study identified both potential and known water sources at Great Zimbabwe. Ethnographic research was one of the methods used in identifying water sources as well as water management systems around Great Zimbabwe. Unless something drastic happens in terms of climate and geological change, water courses and sources remain the same hence the links between the ethnographic present and the pre-colonial period has been important in this study There are a number of inferences that could be drawn from current water management systems among communities around Great Zimbabwe that can help us understand how water was managed at Great Zimbabwe

Using various tools and methods in spatial studies, this book has made a contribution towards space syntax at Great Zimbabwe. Whilst previous attempts at understanding the use of space at Great Zimbabwe have largely focused on the use of ethnography to understand the symbolic significance of certain features and structures, this study has deployed GIS tools to establish the link between water and the built environment By using methods such as Least Cost Analysis, the study generated models that indicate the Least Cost Paths from water sources to particular sections of the site. The employment of GIS tools such as Cost Surface Creation and Analysis has helped in understanding the water catchment of Great Zimbabwe. The study also used GIS tools to understand the interface between the built structure, water sources and routes used to ferry water to dwelling areas.

The study has also contributed towards an understanding of water engineering at Great Zimbabwe through an analysis of how people at Great Zimbabwe devised ways of managing the flow of water by creating drain holes, digging water pits, and constructing retaining (terraced) walls Such engineering works suggest that the people at Great Zimbabwe realised the importance of building structures which could withstand the impact of water by allowing it to flow out of the built environment This also suggests that the water engineering capabilities of the people at Great Zimbabwe may have been hitherto undervalued. This is largely because of the absence of water canals and extensive terraces. A closer analysis of drain holes, *dhaka* pits and terraces provides great insights into the engineering skills of the people who built Great Zimbabwe.

One of the key questions that an archaeological study of water and water management systems at an ancient city such as Great Zimbabwe endeavours to answer relates to the population level at the site The study has, therefore, contributed towards an understanding of the population levels and the social formations at the ancient city of Great Zimbabwe by showing that the water available at the city was enough to sustain an average population. This casts doubt on earlier suggestions by scholars such as Huffman

(1996a) which, without any scientific basis, suggested that the population at Great Zimbabwe was as high as 20 000 With most of the water sources around Great Zimbabwe being ephemeral, it is highly unlikely that the water sources could sustain a large population. A hydrological budget would therefore be a necessity in understanding the population of Great Zimbabwe.

The study makes a case for the need for archaeologists to consider the centrality of water in the everyday lives of people living in ancient cities It argues that although artefacts revealing water management systems, water engineering and the ferrying of water from various water sources maybe difficult to obtain from the archaeological record, evidence from the ethnographic present as well as GIS-aided spatial studies have great potential in unravelling the salience of water in ancient cities.

In addition, the study has examined water management strategies employed at Great Zimbabwe that could be resuscitated in the face of climate change and uncertain weather patterns that the world is facing Furthermore, the study has highlighted the various water management strategies which, when deployed, could benefit the community. Thus, the research addresses issues of the sustainable use of water in the face of climate change since water is pivotal in the existence of people. Water crisis is one of the consequences of climate change. How the water crisis in this century started and how people can solve it are among research areas that scholars have been addressing. It is within this broader debate that some scholars have argued that the major challenge is not water, rather it is what people have done with the water (Mithen 2010). The domestication of water is one of the major causes of the current water shortages and exploitative water management systems in urban centres. The culture of domesticating water is attributed to the consolidation and spread of farming lifestyles, which in turn ignited exponential population growth, and also the development of urban centres (Mithen 2010: 5250). The present study examined what people have done with water at Great Zimbabwe which includes the transportation of water from its sources to various areas where it was used, as well as various water engineering initiatives Spatial archaeology, therefore, offers a window through which people can observe and understand the consumption pattern and management of water

The use of ethnography and archival sources such as aerial photographs and diaries by early visitors to the site has demonstrated how the land-use patterns of the area around Great Zimbabwe have been transformed over time and how the transformations have affected the water resources at the settlement The study has shown that land-use patterns around Great Zimbabwe significantly changed the availability of water. This is evidenced by some of the activities that might have had a direct impact on the water sources around Great Zimbabwe such as the closure of the Chisikana spring to pave way for the construction of the golf course in the 1960s. The dynamics in land-use could have affected the water resource base and ultimate demise of the ancient city.

Overall, this study has emphasised the need to look at ancient cities like Great Zimbabwe as 'lived' landscapes which aids our understanding of the socio-political events of the time. The interconnectedness of the systems in a city structure makes it more prudent to have an interdisciplinary approach to understanding water resources and management in the complex ancient city. The study offers new perspectives on understanding the importance of water and water sources in Great Zimbabwe's space syntax. It calls for the deployment of archival sources, ethnography and GIS tools for the study of the use of space at Great Zimbabwe

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